लाल बहादुर शास्त्री राष्ट्रीय प्रशासन अकादमी
L.B.S. National Academy of Administration
मसूरी
MUSSOORIE
पुस्तकालय
LIBRARY

अवाप्ति संख्या
Accession No. 1279

वर्ग संख्या
Class No. 338.003

पुस्तक संख्या
Book No. Wat

338.003
Wat
1279
LBSNAA

THE COMMERCIAL PRODUCTS OF INDIA

THE COMMERCIAL PRODUCTS OF INDIA

BEING

AN ABRIDGMENT OF "THE DICTIONARY OF THE ECONOMIC PRODUCTS OF INDIA"

BY

SIR GEORGE WATT

C.I.E., M.B., C.M., LL.D. (ABD. AND GLASG.), F.L.S.

Officier d'Académie, Corresponding Member Royal Horticultural Society of England
Honorary Member of the Pharmaceutical Society of Great Britain
Daniel Hanbury Gold Medallist
Formerly Professor of Botany Calcutta University, Superintendent Indian Museum
(Industrial Section) and Reporter on Economic Products
to the Government of India

PUBLISHED UNDER THE AUTHORITY OF HIS MAJESTY'S
SECRETARY OF STATE FOR INDIA IN COUNCIL

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1908

PRINTED BY
HAZELL, WATSON AND VINEY, LD.,
LONDON AND AYLESBURY.

PREFACE

THE history of this Work may be told briefly.

The *Dictionary of the Economic Products of India*, written by me and published 1885–94, having been out of print for some time, it was resolved by the Government of India that a corrected and abridged edition should be brought out. The instructions provided that the work should be limited to a single volume, the arrangement of which should follow that of the *Dictionary*; that it should be confined to products which are of present or prospective industrial or commercial importance; and that Sir W. T. Thiselton-Dyer, Director of the Royal Botanic Gardens, Kew, be requested to exercise supervision over the compilation of the work. In acceding to this request, Sir William recommended that a definite plan for the work should be settled before commencement by a small committee in communication with the author. This recommendation was adopted by the Right Hon. the Secretary of State for India, the committee appointed being empowered to make recommendations on any other points of detail not sufficiently provided for in the instructions issued by the Government of India. The Committee were as follows:—Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E., F.R.S., Director of the Royal Botanic Gardens, Kew, Chairman; Mr. J. S. Gamble, C.I.E., F.R.S.; Professor

Wyndham R. Dunstan, F.R.S., LL.D., Director of the Imperial Institute; and Sir Thomas Holderness, K.C.S.I. Lieut.-Colonel D. Prain, C.I.E., F.R.S., was subsequently appointed a member of the Committee. The writing of the work was commenced in 1904 and completed in 1907. During its progress the manuscript of many articles was submitted to scientific experts who were good enough to allow me to consult them. Among these I may mention the generous help received from the members of the advisory committee, more especially Sir William Thiselton-Dyer, who, during his long and honourable connection with Kew, had gained a unique knowledge of the products of India, and was ever ready and willing to assist in forwarding the best interests of the work. Sir Thomas Holland, K.C.I.E., F.R.S., Director of the Geological Survey of India, kindly perused all the articles on "Metals and Minerals," and made numerous valuable suggestions. Mr. T. H. Middleton, M.A., Assistant Secretary, Board of Agriculture, permitted me to consult him regarding "Live Stock." Dr. Harold H. Mann contributed towards the article on "Tea"; Mr. H. M. Leake, M.A., on "Indigo"; Mr. C. A. Barber, M.A., on "Pepper." Mr. E. M. Holmes was good enough to read the proofs of certain passages on drugs; Professor A. H. Church, F.R.S., very readily responded to my inquiries, and Dr. J. A. Voelcker advised me on doubtful points in agricultural chemistry. Mr. F. W. Thomas, Librarian India Office, rendered invaluable service regarding the origins of Indian classical and vernacular names. Professor E. Rapson, of Cambridge, was similarly good enough to help me on several occasions with the Indian classic authors, Dr. G. A. Grierson, C.I.E., was most liberal in his responses, and Mr. W. Foster was ever ready to supply information regarding the Records of the India Office.

I may venture to explain that an effort has been made to render all trade statistics on the standards of English weights and measures, and while giving the rupee values to state now and again the equivalents in pounds sterling (1*s.* 4*d.* to the rupee). Unfortunately, by the time the press order had to be given, official returns later than 1905–6 were not as a rule available for all aspects of trade, so that while incidentally quoting such returns as were to hand of a later date, the main contentions of the work turn on the positions attained in 1905–6.

I cannot close these explanatory remarks without stating that the bulk of the work has been written from the material sent to me from India by Mr. I. H. Burkill, M.A., Reporter on Economic Products. In connection with the preparation of the *Dictionary* there had been established in that office what have come to be officially known as the "Ledgers." These consist of books of blank paper assorted within boxes according to the names of the products of India. Into the books had been pasted cuttings from numerous publications, official and otherwise, in sequence of date, passing onward to the *Dictionary* and subsequently to the present day. It thus became comparatively easy to ascertain all new particulars, and to verify the data and correct the mistakes of the older work. In a similar manner, though perhaps not on so elaborate a scale, cuttings had been preserved for many years past both in the Revenue and Statistical Department of the India Office and in the Office of the Director of Kew. In addition, therefore, to the material amassed in India, I had placed at my disposal the papers brought together in England in the manner indicated, and the work as issued may, I trust, be found a useful digest, within the previously assigned limits, of all available information. Lastly, I must take the opportunity to acknowledge my great indebtedness to the Librarians of the India Office and of the Kew Herbarium for the limitless facilities afforded me in consulting the numerous works, not recorded in the official ledgers, and for thus having greatly enhanced the value of the historic details. The primary objects kept in view have been to restrict observation to what concerns India, and to make the work of practical value to the Commerce and Industry of that country.

GEORGE WATT.

Kew Gardens, July 1908.

THE COMMERCIAL PRODUCTS OF INDIA

A

D.E.P., i., 7-9.
Perennial Hemp.

ABROMA AUGUSTA, *Linn.:* Roxb., *Trans. Soc. Arts*, 1804, xxii., 382; 1806, xxiv., 151; *Fl. Br. Ind.*, i., 375; Gamble, *Man. Ind. Timbs.*, 1902, 104; STERCULIACEÆ. Perennial Indian Hemp or Devil's Cotton, *ulatkambal, kumal, olak-tambol, sanu-kapashi*, etc. A large open bush, widely distributed throughout the hot moist tracts of India and readily propagated by cuttings.

Fibre.
Medicine.

The bark affords a strong white bast FIBRE, first discovered by Roxburgh in 1801 (*Substitutes for Hemp and Flax*): it is easily separated by retting in water or by decortication. It may be made to yield annually two or three crops of shoots, from 4 to 8 feet long, but according to Gamble requires rich land and plenty of moisture. The root-bark is held in high esteem by Native practitioners as a MEDICINE for dysmenorrhœa. [*Cf.* Cross, *Chem. Exam. in Imp. Inst. Tech. Repts.*, 68; *Pharmacog. Ind.*, i., 233; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 2; *Agri. Ledg.*, 1896, 6; etc., etc.]

D.E.P., i., 9-14.
Crab's-Eye.

ABRUS PRECATORIUS, *Linn.: Fl. Br. Ind.*, ii., 175; Gamble, *Man. Ind. Timbs.*, 1902, 240; LEGUMINOSÆ. Crab's-eye, Jequirity, the so-called Indian Liquorice; a plant more or less sacred, and known by the following names—*rati, gaungchi, gunjhá, guri-ginjá*, etc., mostly traceable to *gunjhá* in the Sanskrit. A beautiful climbing shrub found throughout the plains of India and Burma, and on the Himalaya and other hills up to altitudes of 3,000 feet—cosmopolitan in the tropics.

Weights.
Suís.
Food.

The small shining red seeds are almost universally used by Indian goldsmiths as weights: they average 1·75 grains. The Koh-i-nur diamond was weighed with *rati* seeds. The chief interest turns, however, on the criminal use to which they are put. Ground down to a paste with a little cold water, they are made up into small pointed cylinders (*suís* or *sutarís*), which if inserted below the skin of a bullock, or even of a human being, cause death in a few hours. There were, for example, 20 cases of abrus-poisoning in animals reported from the N.-W. and C. Provinces in 1897-9; from the Panjáb (1897-1903) 16 cases of animal and one of human poisoning; and from Bengal, 5 animal and 3 human cases. The lethal dose (according to Kobert) is only 0·00001 grm. per kilo of the animal's weight. The TOXIC property is due to two proteids—a globulin and an albumose—and is thus closely analogous to the venom of snakes. When boiled, the seeds may be EATEN, since their poisonous property is then destroyed. The roots are sold as an indifferent substitute for liquorice. [The names of a few only of the more important writers need be quoted:—*Warden, Waddell, Sidney Martin, Weir-Mitchell, Reichert, Klein*, etc.; *also Pharmacog. Ind.*, iii. (app.), 151-2; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 98.]

D.E.P.,
i., 14-7.

ABUTILON AVICENNÆ, *Gærtn.; Fl. Br. Ind.*, i., 326-7; MALVACEÆ. The Indian Mallow or American Jute. A small bush met with in North-West India, Sind, Kashmir, etc.

Fibre.
Medicine.

The bark yields a FIBRE, spoken of as superior to Jute (Dodge, *Useful Fibre Plants of the World*, 35). According to Duthie, the fibre is much valued in Kashmir. ***A. indicum,*** *Sweet,* and ***A. asiaticum,*** *G. Don*—two species that from the industrial standpoint cannot be separated from each other. The former is distributed throughout India, in fact the tropics, and the latter is met with chiefly in Western India. They are often spoken of as Country Mallow, *kanghi, jhampi, potari,* etc., the seeds being *balbij.* They yield beautiful white bast fibres, and the leaves, roots and seeds are rich in mucilage, hence used as demulcents, emollients, and diuretics, and prescribed in fevers as cooling MEDICINES.

D.E.P.,
i., 17-61;
iv., 188;
v., 320.

ACACIA, *Willd.; Fl. Br. Ind.*, ii., 292-8; *Agri. Ledg.*, 1902, No. 2; LEGUMINOSÆ. A genus of spinose or prickly climbing shrubs or trees, which constitutes the most characteristic group of plants in the Sub-order MIMOSEÆ. There are in all 430 species, of which two-thirds are peculiar to Australia. India possesses only some 22, and these are distributed throughout the plains, two ascending to altitudes of nearly 5,000 feet. [*Cf.* Prain, *Some Additional Leguminosæ, Journ. As. Soc., Beng.*, 1897, lxvi., 506-11; Gamble, *Man. Ind. Timbs.*, 291-302; Brandis, *Ind. Trees*, 263-9; Duthie, *Fl. Upp. Gang. Plain*, i., 312-9; Cooke, *Fl. Pres. Bomb.*, i., 443-51.]

Commercial Species
Generic Properties.
Fungi and Gum.
Fibre Structure.
Agriculture.
Hedges.
Fodder.

It might almost be said that every Indian species is of some economic value. Three are of commercial importance, viz. ***Acacia arabica, A. Catechu,*** and ***A. Senegal,*** while the remainder are mainly of local interest. The bushy and arborescent forms, as a rule, afford astringent barks, leaves, or pods, and are appreciated as MEDICINES, as TANS or as DYE AUXILIARIES. Many of them afford useful GUMS that are more or less soluble and edible. Interesting particulars regarding the fungi that appear to be instrumental in the formation of these gums will be found in a paper written by Mr. J. B. Prebble, and published in the *Pharmacographia Indica* (i., 544-55). The barks of some species yield coarse cordage FIBRES. The majority of the trees are of the greatest value to the inhabitants of the tracts where they are at all prevalent, both as sources of TIMBER and FUEL. With regard to the timber, Mr. Gamble observes that the Indian species have sharp prominent medullary rays, which are short in ***A. Catechu, ferruginea,*** and ***modesta,*** but long in the others. As a rule they are not well marked in a radial section, but ***A. leucophlœa*** and ***arabica*** are exceptional in this respect, the former being beautifully marked. All the species of ***Acacia*** are recognised as of the utmost importance in AGRICULTURE, as for example in the reclamation of waste lands. Indeed, in certain arid regions, they are the chief trees and shrubs met with. And lastly, either as living hedges or as dead thorny fences their spinose property is much appreciated for the protection of cultivated lands, and the leaves beaten from the twigs afford a much-valued FODDER to the cattle of the regions in which they are plentiful.

Acclimatised Species.

A few foreign species have become completely acclimatised in India, such as ***A. dealbata***—the Australian White or Silver Wattle; ***A. melanoxylon***—the Australian Black Wattle; ***A. decurrens***—the Common Wattle. These are fairly general in the warm temperate tracts of India, more especially in the Nilgiri hills, where they were introduced in 1840. [*Cf.* Maiden, *Gums and Resins of Australia*, 172; Hooper, *Agri. Ledg.*, 1902, No. 1; *Imp. Inst. Tech. Repts.*, 1903, 314-5.]

It may perhaps suffice to deal very briefly with the so-called unimportant species and to touch mainly on their special features of interest, leaving the above general observations as more or less applicable to them all.

D.E.P.,
i., 17-27.
Babul.

A. aribica, *Willd.; Fl. Br. Ind.*, ii., 293. This is the Indian Gum Arabic Tree, the *babúl* or *kikar, babola, gabur, bakar,* etc. Dutt (*Mat. Med. Hind.*, 160) gives it the Sanskrit name of *vavvula,* while *babula* is a word which according to Rice is only Sanskritised, and

Babúl Kikar.

Sir Walter Elliot (*Fl. Andh.*) says it is the *Barbúramu* of Sanskrit. In South India it is known as *karú* (or *karuvelam*), *gobli*, *jáli*, *túma*, etc.

Indigenous.

Habitat.—This is one of the most widely distributed and prevalent of small trees in India, but chiefly on village sites, borders of fields or waste lands, where it is usually seen to be gregarious. It prefers a dry to a moist climate and accordingly is, as a rule, absent from the coast tracts; it disappears gradually from Bengal, Behar and Oudh, on the Terai of these provinces being approached; is absent from the warm moist tracts of Assam, Manipur and Burma; is most prevalent from the North-West Provinces, through the Central Provinces to Berar, Central India, Bombay and Sind; and might be said to attain its greatest development in lower and middle Sind, where it is probably truly indigenous. It does not appear to be a native of many parts of India, where it is nevertheless common, *e.g.* the Panjáb, Oudh, Bengal and Madras. In the Panjáb it is mainly grown on canal embankments, and in the United Provinces by roadsides and on islands in the Ganges. [*Cf. Rept. Arboricult. in Pb.*, 1890-3, 6.]

Three Forms.

Varieties.—Some short time ago Sir Dietrich Brandis (*Ind. For., Sept.* 1897, 23, 359) raised the question of the varieties of this species. He referred to the *kaulia babul* of Berar (the *kowri*, *kaoria*, and *vedi*—mad—of the Deccan) as a small tree with deeply cracked and exfoliated bark, broad marginate pods, and stouter spines than the ordinary form which in Akola is distinguished as *telia babul* (the *godi* (sweet) *babul*, according to Fagan, Shuttleworth, etc.). Another variety is the cylindrical *babul* known as *ram-kanta* (possibly the Kabul or cypress *babul* of certain writers. [*Cf. Panjab Gaz.* (*Sialkot*), 1894, 11; Gamble, *Man. Ind. Timbs.*, 292; Cooke, *Fl. Pres. Bomb.*, i., 444.] The *kaulia* or *kauria* is a smaller tree, grows on poorer soil, and affords a much less valued timber than the ordinary or *telia babul* (Brandis, *Ind. Trees*, 264). It would seem that the well-known variability of ***Acacia arabica*** in merit of gum tan and timber afforded, may to a large extent be dependent on this question of the varieties or climatic conditions of the species, hence the subject is well worthy of careful consideration.

Conclusion regarding Varieties.

Cultivation

Methods of Sowing.

Cultivation.—The *babul* is raised from seed, bears transplanting indifferently, and according to some writers may be propagated by cuttings. It can be sown by drill or by being broadcasted, and in either case just before the rains or, say, in June and July. The seeds germinate slowly, for they are exceedingly hard, and it is customary to soften them by steeping for a day or so in water or in liquid cow-manure. The seed is generally gathered in April, and by the Native cultivator is often coated with cow-dung and kept in that condition till July, then sown on the spot where intended to be grown. Most writers affirm that germination is best effected by making goats or sheep first eat the seeds. This, however, would seem to be a mistake, for these animals will not eat shelled seeds and do not care much for ripe pods; they prefer green pods with immature seeds. When mature the animals eject them from the mouth during rumination, and the seeds thus never actually pass through the alimentary system. If, however, they chance to be retained for some hours in the first stomach of a ruminant the seeds would no doubt be found to germinate freely.

Weeded out.

Perfect Condition of Bark.

The plants have to be thinned out about the third year until the healthiest occupy distances of from 10 to 20 feet apart. In the third year they will flower and bear fruit; and according to the experts of the tanning industry in Cawnpore, the bark is in its most perfect condition when the trees are from 4 to 6 years old. Curiously enough, however, many Natives affirm that the older the trees are the stronger the tanning property. This does not appear to be the case, for according to European tanners the colouring principle develops but the tanning value decreases with age. If, therefore, *babul* plantations be raised with a view to returns from tanning-bark and fuel, the trees should be uprooted after from 6 to 10 years, in order to secure the best financial results. At one time it was supposed that a system of pollarding plantations might be the most remunerative, but plants so treated have been observed to grow so very slowly afterwards that it has proved preferable to uproot and replant. The bark is sometimes stripped off the living plants, but the wounds heal so very badly that this is by no means an approved method of procedure. [*Cf.* Fagan, *Ind. For.*, x., 393, 441; Lushington, *Ind. For.*, xxi., 252.]

Pollarding Plantations.

Stripping Bark.

Costs.

Cost of Production and Profit.—Mr. Ozanne (*Letter* No. 607, *dated July* 1884, para. 16) furnishes returns given by a Parsi gentleman of Gujarat. Briefly these may be said to give the cost of cultivation and rent of land for 10 years

Fodder.

Fuel.

as Rs. 24, and the gross proceeds for grazing and fuel as Rs. 251, thus leaving a net profit of Rs. 227. Dr. Leather (*Agri. Ledg.*, 1896, No. 18, 158) shows the working expenses for an acre of land in Agra under *babul* as Rs. 146 and the gross receipts Rs. 440, so that the net profit in 10 years came to Rs. 294. But in neither of these cases does allowance appear to have been made for the sale of bark, the plantations having been undertaken simply for fuel purposes. In conclusion it may be observed that on good soil the tree is much less gregarious, is allowed to grow to a fairly large size, and is accordingly valued more as a timber tree than as a source of fuel. A tree is considered full-grown in from 20 to 40 years, and may then fetch from Rs. 40 to Rs. 100 according to the size of the timber afforded.

Bark.

Markets.

The variety (mentioned above) as *kaulia* or *vedi* is that usually grown in Berar and Western India, when fuel only is desired. The *telia* or *godi* is ordinarily allowed to run to timber. Success in cultivation would seem to depend upon several circumstances, such as the scarcity and consequent high price of fuel, a good market for the bark, the existence of suitable land at low rents, etc., etc. But it must never be forgotten that, to be successful, production of *babul* fuel and *babul* bark must be in close proximity to the markets, since neither product could bear heavy railway freights.

Soil.

Successful Cultivation.

Soil.—According to most observers the *babul* prefers a sandy light loam or black cotton soil to heavy clay, but appears to be somewhat indifferent to the presence of a fairly large percentage of *rêh* or *shor* (efflorescent salts—see **Alkalis**, pp. 51–6). But it does not succeed either on rocky and hilly ground or on low-lying and submerged tracts, hence plantations to be made profitable must be on fairly good soils. The yield and quality of the gum, of the tanning bark and of the timber—its three chief products—greatly depend on the condition of the plant.

Longicorn Beetles.

Enemies.—The life of the tree is generally said to be about 20 to 30 years; at all events after that age it seems to become a ready victim to the ravages of various pests, among which the grubs of one or two longicorn beetles may be specially mentioned. Mr. Stebbing (*Injurious Insects of Forest Trees*, 67, 69) describes these as ***Cœlosterna spinator*** and ***Pachydissus holosericeus.*** Its greatest enemy, however (especially during the first 3 or 5 years of its existence), is probably the goat.

The commercial products and utilisations of *babul* may be dealt with under the following headings:—

Gum.

Yield.

Tapping.

1. ***The Gum.***—This exudes in March, April and May, according to the vast majority of reports, but in connection with Amritsar it is said to ooze from the trees in the months of October, November and December. A tree yields a maximum of about 2 lb. a year, but the average might be more safely put at a few ounces. In certain localities little or no gum is given by the trees, and seasonal variations in yield are also well known and are said to be dependent on abnormal climatic conditions. Tapping the trees is generally believed to accelerate the flow, but this is not often practised, and may be detected by the presence of long stalactiform masses.

Physical Features.

Atmospheric Influences.

Colour.

The gum occurs in the form of irregular and broken tears agglutinated, each tear being half an inch in size and of a pale straw-colour to red, brown or almost black, according to the age of the tree. The quantity yielded varies directly, but the lightness of colour and quality, inversely to the age of the tree. Such, at least, is the general opinion, although the Amritsar report states that old trees do not yield any gum at all. Long exposure to atmospheric influences, more especially to damp and rain, darkens the colour and lowers the value of the gum, besides making it astringent owing to the quantity of tannin (from the bark, doubtless) with which it becomes charged. [*Cf.* Vilbouchevitch, *Journ. d'Agri. Trop.*, 1901, i., 49.] Observers have also noted that gum exuding from gnarled stems or diseased portions is dark; moreover, that it varies in colour and becomes brittle by exposure to the sun or artificial heat. [*Cf.* Goetze in *Pharm. Zeit.*, 18, 119; *Journ. Chem. Indust.*, 1903, xxii., 429.] The purer and paler-coloured gums

Chemical Reactions.

reduce Fehling's solution only slightly, are darkened in colour by ferric chloride and gelatinised by borax. The darker samples (highly charged with tannin) are precipitated by basic acetate of lead, form inky colorations with ferric chloride, deep brown with bichromate of potash and red with molybdate of ammonia. They freely reduce Fehling's solution. Moreover, the darker portions are much less soluble in water and leave a gelatinous portion undissolved. [*Cf. Pharmacog. Ind.*, i., 551.]

Industrial Uses. **Mortar.** **Medicinal Uses.**

Uses.—Indian gum arabic is used in CALICO-PRINTING and in all other industries where a mucilage is necessary and in which the peculiar properties of this particular gum are recognised as specially suitable. Amongst other minor purposes it is, for example, employed as an ingredient in whitewash and in paints used for wall-distempering. It is added to certain MORTARS and to paints that are used for clay toys. As a MEDICINE it is an indifferent substitute for the true gum arabic of European pharmacy. It is often used as a vehicle for castor oil, and has the merit of absorbing the offensive smell. One drachm of gum dissolved in ½ oz. of water will carry 1 oz. of castor oil. Its use in lozenge-form is diminished by the fact that it is less soluble than the true Gum Arabic. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 142–3.]

Famine Food. **Sweetmeats.**

At one time the gum was said to form an important item of human FOOD in times of scarcity, but recent inquiry has brought out a flat contradiction of that statement from almost every district in India. The gum at all seasons is several times as expensive as the grains eaten by the poor; preferably, therefore, they would purchase grain with it. It is nowhere so abundant as to become a famine food. It is, however, unquestionably edible, and fried with *ghi*, sugar and spices, is employed in the preparation of certain Native sweetmeats which are very generally eaten after child-birth.

Variation in Quality. **Best Edible Gum.** **Umrawatti Gum.**

So far as they have proceeded, the investigations into the Indian gums suitable for the European confectionery trade have revealed several very surprising circumstances connected with this gum. There are, for example, great variations in quality, which are not alone to be explained by adulteration with inferior gums. Not only does the quality depend largely on the age and variety of tree, but on the locality of production. Thus two samples, one said to have been the best quality from Nagpur, the other from Cawnpore (both believed to have been authentic samples of *Acacia arabica* gum), were forwarded to Messrs. Rowntree & Co. for examination and report. The reply which came in due course was—"They gave exceedingly dark solutions of medium strength, but both are quite useless to us on account of the colour." A third consignment procured from the Panjáb was said to give "a pale solution, very thin and probably of little value for any purpose." The best Indian edible gum, from Messrs. Rowntree & Co.'s standpoint, would appear to be that referred to under *A. Jacquemontii.* It would thus seem that, far from *Acacia arabica* affording the best edible gum arabic of India, it might almost be described as the least important of all the Indian edible gums. It seems, however, probable that *babul* gum from Sind may be of a much superior quality to that from other parts of India. As met with in trade this gum comes mainly from the Central Provinces and Berar and is known in Bombay as *Umrawatti* and *Amrad.* But attention may here be called to the circumstance often discussed (*e.g.* by Vilbouchevitch, *l.c.* 48), that all gum from the same species and even from the same tree is not of equal quality. The variation is doubtless due to bacillic action, and ants have been spoken of as facilitating the ingress and dispersion of the bacilli.

Price.—The information available regarding the price at which the gum can be procured is so conflicting as to render the returns practically worthless. They range from Rs. 12 to Rs. 50 per 100 lb.

Babul-bark Tan.

2. ***The Tanning and Dyeing Bark.***—*Babul*-bark is perhaps one of the most extensively used and most highly valued of the crude tanning materials of India. It is in fact, with many of the Native tanners, the chief TANNING SUBSTANCE in practically all provinces except South India, where its place is to a large extent taken by the tanner's Cassia (*Cassia auriculata*). It is also very extensively employed by the dyers because of the rich colours it affords. In a work such as the present, space cannot be afforded to deal with the methods of dyeing and tanning pursued, nor to furnish the formulæ of the special preparations employed. The reader must consult the *Dictionary* and other such works for all details.

Source of Bark.

Source.—The introductory paragraphs of the present article have already set forth some of the practical considerations regarding production of *babul*-bark. It is commonly obtained from trees felled for fuel, and the bark very often becomes the woodman's wages. So again the observation has been made that the bark from old trees is not so valuable as that from trees 6 to 10 years of age. In order, however, to obtain perfectly trustworthy information on this point an extensive series of barks from a selected number of districts was procured from trees of various known ages and during certain fixed seasons of the year. [*Cf. Agri. Ledg.*, 1896, No. 9, 42, 54–5.] Apparently no report has as yet been published of the results arrived at by the examination of the barks, thus specially brought together for that purpose. Hooper, however, affirms that "the tanning content undoubtedly increases with the age of the tree" (*Agri. Ledg.*, 1902, No. 1, 23), and he cites a report of Mr. J. Teil of date 1845 in support of that opinion which is exactly the opposite of the modern view held by the European tanners of India. Recent inquiry has, however, been prosecuted sufficiently far to reveal the circumstance that *babul*-bark is hardly likely to compete successfully with the tanning materials already procurable in Europe, and that very possibly it will never even pay to manufacture for export a tanning extract from this bark or from the bark and pods combined. Much has been written on this theme, but it may be said that the chief claims of *babul*-bark turn on its cheapness and abundance. It is bulky and the percentage of tannin is small, hence it cannot be profitably carried for more than short distances. Accordingly the conclusion must be that *babul*-bark is a tanning material of great local value, but one that stands a poor chance of being exported to any appreciable extent.

Percentage of Tannin.

It contains 18·95 per cent. of catechol tannin, which takes a beautiful cream colour when precipitated with gelatin. Martin says that ¾ lb. of the bark suffices for each maund of hides. [*Cf. Monographs, Tanning, and Working in Leather* :—Walton, *U. Prov.*, 23 ; Martin, *Bomb.*, 7 ; Chatterton, *Madras*, 26 ; Rowland N. L. Chandra, *Bengal*, 11–2 ; C. G. Chenovix Trench, *C. Prov.*, 7.]

Price and Supply.—Very little of a definite nature can be published on these subjects. It has been reported recently that the annual consumption in Cawnpore alone is over 200,000 maunds, valued at eight annas a maund. But Cawnpore is the great tanning centre of India, and, therefore, its transactions represent a very large slice of the total traffic in the bark. Quotations have been obtained from Dumraon, Bandelkhand, the Central Provinces, Shahpura (in Rajputana), Delhi, Poona, etc., etc., which show that the bark fetches from 8 annas to as much as Rs. 2–4 per 100 lb. These and such as these are the returns that have come to hand, and they afford very little trustworthy information other than that the bark is a local product which in point of price is, like most other commodities, influenced very greatly by the laws of supply and demand.

Babul-bark is extensively employed in India as an astringent MEDICINE, and the ashes as a dentifrice. Medicine.

3. ***Tanning Pod.***—Roxburgh (*Trans. Soc. Arts*, 1805, xxiii., 408–10) was apparently the first person to draw the attention of Europe to the large and valuable supply of these pods that might be procured from India. This subject did not, however, seem to attract much attention until 1884, when an absurdly high valuation as a TANNING MATERIAL was attributed to the pods. It was then affirmed that when crushed and freed from seed, they would fetch £40 a ton, or 50 per cent. more than was then being paid for oak-bark. This naturally led to numerous experiments to test the yield per acre, the cost of production and methods of crushing and baling the material. When the desired report finally came to hand from England, *babul*-pods ceased to attract attention; they had been found to contain at most 9½ per cent. of tannin, and could not bring more than £10 a ton. All interest in the subject died as quickly as it had arisen. A more hopeful result seems, however, to have been obtained by Mr. Chatterton. *The Agricultural Ledger*, (1896, No. 9, 46) may be consulted for further particulars. But crushed *babul*-pods impart a beautiful colour to leather, and mainly on that account enjoy a certain local reputation as a weak tanning and dyeing material, useful in conjunction with other substances. At the Cawnpore Tanneries the pods are employed almost exclusively for the purpose of removing the lime from skins and hides, before tanning the latter with *babul*-bark or other substances. The dyers of India often utilise *babul*-pods to obtain certain shades that are admired in calico printing.

Pods.

Spurious Reputation.

Percentage of Tannin.

Use.

An extract may be prepared from the immature pods by inspissation. This was known to the Ancients, and through the Greeks reached the Arabs, to whom it was known as *akakia*. To this day a DRUG comes to India under that name from Turkey and Persia, and is sold by most Muhammadan druggists. The unripe pods reduced to a powder are used as a domestic medicine in all cases where an astringent is indicated. They are employed in the manufacture of TOOTH-POWDER, and along with sulphate of iron in the preparation of ink. The tender young pods are eaten as a VEGETABLE, especially in times of scarcity. They are often pickled (*achar*) and viewed as a luxury, especially by the Marwaris. The green pods with their seeds are regularly given as FODDER to goats, sheep, cows, and camels. In Sind the green pods are much appreciated, and in the early part of the hot weather, during April and May, the sale of green pods forms an important item in the forest revenue of that Province. In the Annual Reports of the Forest Department for Bombay (including Sind) the amounts credited as realised on this heading average from Rs. 12,000 to Rs. 30,206.

Tooth-powder.

Ink.

Fodder.

Much valued.

4. ***Tanning Leaves.***—Most of the older writers speak of the leaves of this tree being also used as a TAN, but according to voluminous opinions recently to hand this would appear to be a mistake. They are sometimes employed in dyeing, and are also often utilised in the manufacture of ink, so that they do possess tannin but in such small quantity as to be useless as a tan. The chief value of the leaves is as FODDER, especially in times of scarcity or famine. Beaten from the lopped and dried spinose branches, they are regularly given to cattle. Although the tree is never leafless, fresh foliage appears from February to April. The value of this source of fodder when rain fails cannot be overstated, as the tree is thereby little, if at all, affected in the production of foliage.

Dye.

Ink.

Fodder.

The leaves constitute an ingredient in the intoxicating drug of Indian hemp known as *madak*, and it is said that in a similar way they are also made up with opium.

Minor Uses.

Tooth-brushes.

Baskets.

Fishing-hooks.

5. ***Minor Industrial and Agricultural Uses.*** — One of the most widely known of the minor uses of the plant is for tooth-brushes. Short twigs are made up into small bundles of about 100 each and in that form are exported as a regular article of trade from Karachi to Bombay and practically all over India. They are very extensively in demand by the Marwaris ; on being used the end is chewed until it forms a sort of brush. Very strong and durable baskets are also plaited of young green *babul*-twigs. In fact, this is the chief basket of the agricultural and industrial classes of many localities (see **Basket and Wickerwork, etc.**, pp. 114–6). In some parts of the country fishing-traps are similarly constructed of the young shoots and the spines are occasionally employed as fishing-hooks or as pins to fasten together the leaves used as platters. Crude ropes are sometimes made of the bark fibre.

Lac.

Agricultural Shade.

Reclamation.

Hedges and Fences.

In Sind (and to some extent also in the Panjáb) *babul* is one of the important trees on which the LAC insect is reared. The reader will find full particulars on this subject in *The Agricultural Ledger* (1901, No. 9). To the Indian cultivator *babul* is of the greatest possible value. It does not afford much shade, and yet curiously enough very little except grass will grow underneath it. On this account it is rarely, if ever, allowed to get established in the middle of fields. For avenue purposes, where shade is required, it is not a desirable tree. But in the RECLAMATION of waste lands *babul* is invaluable, especially where *reh* efflorescence gives cause for anxiety (see **Alkalis and Alkaline Earths, p. 55**). Grass rapidly becomes associated with it, so that grazing affords a distinct source of revenue in *babul* plantations. [*Cf.* Ribbentrop, *Ind. For.*, April 1900, xxvi. ; Moreland, Director of Agriculture in the United Provinces. *Official Reports regarding the Abhuspur* (*Oudh*) *Experiments.*] Sown thickly as a HEDGE, *babul* forms a great protection both against animals and the parching, dust-laden winds. As dead fences, the spiny boughs are universally employed to afford temporary protection to valued crops. For these and similar reasons extended cultivation of this tree should invariably be commended in all suitable localities.

Timber.

Agricultural Implements.

House Construction.

6. ***The Timber.***—This TIMBER is highly appreciated for all forms of agricultural implements, because of its hardness and durability. It is especially valued for cart-wheels. In Bengal, the United Provinces and the Central Provinces the timber is rarely, if ever, employed in house construction or for furniture, as it is supposed to be very unlucky. But in the Panjáb, Sind and Bombay no such superstition exists, and accordingly it is frequently utilised in house-building and is much appreciated where great strength is desired. In Bijapur it is in demand for the construction of the carts for which that town is famous. When used for furniture, especially wood-carving, the timber is previously carefully seasoned in water. Recently it has been suggested that *babul*-wood might be employed for wood-paving. A writer in *Capital* (March 5, 1903) believes that this would be found cheaper in the long run than the present method of metalling. The wood when seasoned is very durable and much easier to cut and shape than the timbers most largely used for paving-blocks.

Fuel.

As a source of FUEL or CHARCOAL *babul* justly holds a high position in popular favour. Its cultivation in the vicinity of all large towns would seem highly profitable. An average-sized tree will give 5 maunds of fuel, besides branches and bark that bring in additional returns. Some few years ago a scare was started by the Madras Railway that *babul* fuel injured the boilers. This point has been freely discussed since then. The practical result may be said to be the conclusion that, as compared with coal, all forms of wood fuel are injurious. *Babul* is not more injurious than other timbers, and moreover it has so high a calorific value that it is not only extensively used at the cotton and other mills and on the railways of Upper India, but would be even more extensively employed were it procurable in sufficient abundance.

D.E.P., i., 27-44.

A. Catechu, *Willd.; Fl. Br. Ind.*, ii., 295; Heuzé, *Les Pl. Indust.*, 1895, iv., 288–92 ; Prain, *Some Additional Leguminosæ, Journ. As. Soc., Beng.*, 1897, lxvi., pt. ii., 508–9 ; Gamble, *Man. Ind. Timbs.*, 296–8. This is the Cutch or Catechu tree, the *khair* or *katha*. Prain has rendered valuable service by establishing the characteristics and respective areas of distribution of the three forms of this plant. These are briefly as follows :—

Varieties.

Kumaon *Kath*.

Varieties of the Species: **Var.** (*α*) **Catechu.** *Calyx, petals and rachis with spreading hairs.*—This is the most northern form, having been recorded as met with in Hazara, Kashmir, Simla, Kangra, Garhwal, Mussoorie, Central India, Bihar, and as far south as Ganjam. But it has never been found in the Eastern Himalaya nor in Assam, and it has been only once reported as met with in Burma. This is, therefore, the *kath*-yielding form of Kumaon—the pale cutch, as it is sometimes called, the *khair, khoiru*, etc.

Pegu Cutch.

Var. (*β*) **Catechuoides.** *Calyx and petals glabrous but the rachis puberulous.*—This is met with in Bengal from Monghyr and Patna to Sikkim, Assam and Burma. Though quite common in Pegu and Prome it has not as yet been collected in the Shan hills nor in Upper Burma to the north of Ava. It is, therefore, the cutch-yielding plant of Burma, and " Pegu Cutch " is the chief commercial form of the extract. Its best names are *khair, koir, sha*, etc.

Madras and Bombay Cutch.

Var. (*γ*) **Sundra.** *Calyx, petals and rachis, all glabrous.*—This is the Southern and Western plant and affords the cutch of Madras and Bombay Presidencies, being very common from Coimbatore northwards to the Deccan, Kanara and the Konkan, and has been recorded so far to the north-west as in Kathiawar and Rajputana, and to the north-east in Burma, at Segain, Mandalay, and the Shan hills. It is the *lal-khair* (red Catechu), the *nallasandra* (or simply *sandra*, or, as Sir Walter Elliot renders it, *chandra*), also the *kati, kute, kachu, kagli, kempu, shemi, karangalli, bágá, banni*, etc. [*Cf.* Cooke, *Fl. Pres. Bomb.*, i., 448; Hooper, *Rept. Labor. Ind. Mus.* 1903–4, 28.]

Properties and Uses.

Chief Products.—These three forms of *var.* ***A. Catechu*** are said to be practically identical in their properties and uses. They all yield a GUM, an astringent EXTRACT and a useful TIMBER.

Gum.

The GUM is of a pale yellow colour and often occurs in tears one inch in diameter. It is sweet to the taste, soluble in water, forms a strong pale-coloured mucilage and is not precipitated by neutral acetate of lead, but gelatinises with basic acetate of lead, ferric chloride and borax. It freely reduces Fehling's solution. It is a better substitute for the *True Gum Arabic* than is *babul* gum. Most of the superior qualities of INDIAN GUM ARABIC, especially those of South India, are very possibly obtained from this species of Acacia.

Timber.

THE TIMBER.—Sapwood yellowish-white, heartwood either dark or light red, extremely hard. It seasons well, takes a fine polish and is extremely durable. It is used for all kinds of agricultural implements, wheelwrights' work, etc. In Burma it is employed for house posts and very largely as fuel for the steamers of the Irrawaddy Flotilla. The FUEL of dead *khair* is much valued by goldsmiths. In Northern India cutch wood is made into CHARCOAL, and is regarded as one of the best woods for that purpose. It has been pronounced good for railway sleepers. A cubic foot of *variety* (*α*) weighs from 50 to 60 lb.; of (*β*) about 60 to 70 lb., and of (*γ*) slightly more. But it is as the material from which CUTCH extract is prepared that the wood of this plant attains its greatest value.

Charcoal.

THE EXTRACT CUTCH OR CATECHU.

It is not proposed to deal with this substance very elaborately in the present work. The article in the *Dictionary*, amplified as it has been by *The Agricultural Ledger* (1895, No. 1; 1896, Nos. 2, 35; 1902, Nos. 1, 2; 1906, No. 3) contains practically all that is known. The reader is referred to these publications, and the remarks that follow must, therefore, be accepted as an abstract intended alone to set forth the aspects of commercial interest :—

Commercial Forms.

Commercial Qualities of the Extract and Methods of Manufacture.—How far the peculiarities of the above-mentioned trees account for the different properties

Exported from Cambay.

of the extract, appears never to have been ascertained. It may be mentioned as a curious circumstance, very possibly connected with ***A. Sundra***, that one of the earliest European writers, Barbosa (1514 A.D.) speaks of *cacho* as exported from Cambay to Malacca. The name *cacho* would seem to be simply the Kanarese *kachu*, and very possibly gave origin to the modern Latin name *Catechu*. In 1574 Garcia de Orta (*Coll.*, xxxi.) gave a complete account of the plant, and of the manufacture of the extract under its Tamil name of *kati* (*cate*), a word which by some authors gave the first half of the name *Catechu*, the second being derived from *chuana*, to distil. It is probable, however, that although the earliest European authors saw the extract being prepared from ***A. Sundra***, the Pegu form is quite as ancient if not more so. It was not, however, until the seventeenth century that *catechu* attracted the attention of Europe. It was then supposed to be a natural earth, and as it reached Europe by way of Japan it received the name of TERRA JAPONICA. About the same time GAMBIER also found its way to Europe, and was designated *Terra Japonica* indiscriminately with *catechu*. Cleyer exploded the mineral notion of these substances, by republishing in 1685 Garcia de Orta's account of the preparation of the extract. He affirmed that the best quality came from Pegu, other sorts from Surat, Malabar, Bengal and Ceylon.

Terra Japonica and Gambier.

There are said to be three forms of this substance: (1) DARK CATECHU or Cutch, chiefly used for industrial purposes; (2) Indian PALE CATECHU or *kath*—a crystalline substance eaten in *pan* or used medicinally; and (3) KEERSAL (*kirsal*), a crystalline substance found embedded in the wood, much after the same fashion as Barus camphor. To obtain the cutch the trees have to be felled, but the destruction is conducted in so ruthless a fashion, and so widespread is the demand, that many officers affirm the total extinction of the tree is threatened [*Cf. Upper Burma Gaz. Shan States*, 1900, ii., pt. i., 314; *For. Admin. Rept. Pegu Circ.*, 1900-1, 10; *Summary Settl. Operations, Lower Chindwin Dist.*, 1901-3, 3; Hooper, *Rept. Labor. Ind. Mus.*, 1904–5, 26–7; 1906–7, 10.]

The following particulars may be given regarding the manufacture of the two first-mentioned extracts:—

Pegu Cutch.
Three men work together.

1. ***Dark Catechu or Pegu Cutch.***—Three men generally work together: one cuts down the trees and drives the cattle that drag the logs to the site of the furnace; the second clears off the sapwood and cuts the heartwood up into the little chips required by the third man, who attends to the furnaces and boilers. The chips are packed into earthen pots holding three to four gallons of water, and the whole is boiled down to one-half; the chips are then taken out, and the liquid of 20 to 25 pots is gradually poured into a large iron pan or cauldron, and again boiled and stirred and fresh liquid added from the earthen pots until the fluid attains the consistency of syrup. The cauldron is then taken off the fire and the contents stirred continuously with a wooden paddle for four hours or more, till the mass cools and can be handled. It is then taken out and spread on leaves arranged within a wooden frame, like a brick mould. It is left over-night, and in the morning the extract is dry and ready to be cut up into pieces for the market. It might then be described as a brick of cutch weighing 36 to 44 lb. A picturesque and illustrated account of the work is given by a correspondent in *The Empress* (July 1903).

Iron Cauldron.
Stirring.

After Treatment

The chips are sometimes boiled down a second time, but as a rule very little is extracted by this further boiling. Much difference of opinion prevails as to the necessity of beating the liquid after the cauldron is taken off the fire. Some manufacturers are satisfied with half an hour, others give it as much as four or five hours.

Season of Working.

Cutch manufacture takes place from June 1 to March 31, but the months of December to March inclusive are those of most energetic operations. The produce of each cauldron is approximately 36 to 44 lb. a day, but the total yield during the season cannot be accurately determined since much depends on the quality of the trees, their proximity to the boiling place and, above all, the working days of the season The proceeds of one cauldron may be 2,000 lb., or it may exceed 6,000 lb. As to the yield of cutch per given weight of heartwood, it is believed that a ton of wood might be taken as yielding 250 to 300 lb. of cutch.

Yield.

Other Forms of Cutch.

In the western and northern tracts of India, such as Kanara, Dharwar, Khandesh, Surat and Baroda, and to some extent Chota Nagpur in Bengal, Dehra Dun and Gonda in Oudh, dark-coloured cutch is also prepared by a process that only differs in minor details from that briefly described in connection with Pegu. The industry in these regions is on a much smaller scale and the appliances are correspondingly less perfect, but the principle involved is the same. In Gujarat, as a rule, the trees are not felled, but the larger branches are simply lopped off, and these are cut and boiled down into cutch. The article from these localities as met with in the market differs, however, materially in external appearance and shape from Pegu cutch. It occurs in small cubes, flat cakes or rounded balls, and is of a redder colour and more opaque fracture. The influence of the method of manufacture, more especially the use of iron cauldrons, will be discussed in a further paragraph.

Method of Preparation.

2. ***Pale Catechu*** or the crystalline substance known as *Kath.*—This is the restricted name, given in Northern India to a grey crystalline substance prepared from a concentrated decoction of ***A. Catechu*** wood by placing in it a few twigs and allowing the decoction to cool. The twigs are removed and the crystalline substance found adhering to them is collected and pressed into large irregular cubes. Whether the liquid is rejected or is afterwards boiled down to produce a poor quality of dark catechu or cutch has curiously enough not been recorded. The cubes of grey crystalline substance are the *kath*, which is eaten by the Natives in their *pan* and which imparts with lime the red colour to the lips. It is, apparently, hardly ever exported to Europe, and the name *kath*, while chiefly applied to it, is in some parts of India unfortunately also given to cutch. *Kath* and cutch have by Europeans been mistaken for the same substance, but the former is much purer chemically than the latter, and it may be owing to the fact of cutch being the form exported to Europe that catechu has lost the former position it held as an astringent MEDICINE. It seems probable that the preparation of *kath* may be a secondary process from the cutch, since its direct preparation from the original decoction has only been observed at Kumaon, although the substance is universally used in *pan* all over India. This subject deserves to be thoroughly investigated, and the merits of *kath* and its process of preparation made better known. In a further paragraph will be found an abstract of recent investigations that have a bearing on the issue here raised. [*Cf.* Madden, *Journ. As. Soc. Beng.*, 1848, 565.]

Kumaon *Kath.*

Medicinal Form.

Secondary Manufacture.

Khersal.

3. ***Keersal or Khersal.***—From the wood of ***Acacia Catechu*** is occasionally obtained a pale crystalline substance known as *khersal.* The woodmen, when cutting up the timber for fuel, sometimes come across this substance and carefully collect it, since it is much valued as a medicine by the Hindus, and fetches a high price. [*Cf.* Dymock, *Mat. Med. Western Ind.*, 232 ; *Bomb. Gaz.*, vi., 13.]

Dr. Warth's Investigations.

Catechu-tannin and *Catechin.*

Recent Investigations.

Preparation of *Kath.*

Improvements in Manufacture.—*The Agricultural Ledger* (1895, No. 1) records Dr. Warth's experiments in the manufacture of cutch, with the results obtained and the correspondence that ensued on his recommendation for the establishment of central factories under Government control. Warth showed that the Native system was wasteful and destructive, more especially through the use of iron cauldrons. He explained that the active principle of cutch was the tannin known as *Catechu*-tannin. This forms a greenish-brown compound with ferric salts. There is also present, however, another substance known as *Catechin*, and this is the active principle in *kath*, or the edible form of cutch. Catechin is, however, easily changed into tannin. It is soluble in hot water but practically insoluble in cold water, while *catechu*-tannin is completely soluble in cold water. From this simple fact Warth proposed that catechin should be invariably separated from the catechu-tannin and sold by itself, but he showed that it was essential that this should be accomplished by a rapid process and in concentrated solutions. Etti had previously pointed out these peculiarities, but Warth gave them a practical value. The concentrated decoction is by him recommended to be set aside for five days, to allow of the formation of the crystalline catechin. Cold water is then added and the solution filtered, and the filtrate again boiled down to form cutch free from catechin. As already suggested, it seems probable that by some such process *kath* may be regularly manufactured by the drug dealers of India, since the Kumaon supply could hardly suffice to meet the Indian consumption.

Wood-spotted White.

Warth then demonstrated the injurious action of iron on catechin, and urged that the cauldrons used should invariably be copper. His observation that wood spotted with white deposits is richest in catechin, and that such wood is more prevalent in Oudh than in Burma, confirms a widespread Native opinion, and probably points to something peculiar in the variety of plant grown in Oudh (*var. α*, ***Catechu***, above), as compared with that of Burma (*var. β*, ***Catechuoides***).

Dr. Leather's Investigations.

Commercial Valuation.

Important Consideration.

Great Economies.

The inquiry was next prosecuted by Dr. Leather, Agricultural Chemist to the Government of India. His assistant, Mr. Collins, furnished a most instructive table of analysis, in which he showed that commercial valuations rarely coincided with percentage of catechu-tannin and catechin (more especially of the latter), but were dependent mainly upon the appearance of the extract. So far as the tanner is concerned the complete absence of catechin might be said to be a recommendation. Leather dealt in a most interesting manner with the best methods of cutting up the timber, with the effect of different kinds of water, the quantity of water required, and the time which was essential to boil the wood. He showed that it would be more economical to reduce the wood to shavings by the carpenter's plane than to cut it into chips as at present. When reduced to shavings the yield of catechu-tannin and of catechin was much higher than with chips; the proportion of water to weight of wood could be reduced from 20 to 10 or even less; and the duration of boiling might be reduced from twelve hours to half an hour. All these circumstances indicate not only vast financial economies, but the production of a superior quality of extract, owing to the smaller amount of boiling that is necessary. The separation of white catechu (or catechin) from cutch (or catechu-tannin), might be made a commercial success if accomplished from an extract prepared in the manner indicated by Leather.

Dyes.

In *The Agricultural Ledger* (1896, No. 35) will be found the results of Professor J. J. Hummel's and Mr. Reginald B. Brown's chemical investigations into the dyeing properties of catechu-tannin and catechin. Briefly, they have demonstrated that both these substances may under certain circumstances be used as dyes. [*Cf. Journ. Soc. Chem. Indust.*, March 31, 1901, xx., 246.] The present purpose has been to convey the facts of commercial importance and the bearings of recent research (both botanical and chemical) on possible developments of the cutch industry.

Trade.

Production and Trade in Cutch.—Trustworthy returns are not available regarding the production of cutch in India. The trade is very largely in the hands of small manufacturers and dealers. As a rule the right to work the cutch forests belonging to Government is granted by license and sold by auction or tender. The period for which the licenses hold good is usually four months. *Commercial Circular* (1896, No. 11) gives certain particulars of interest regarding the Burma trade. It is calculated that on the average 80 cutch trees are used per cauldron, and as the average price paid for the cauldrons comes to Rs. 225, the average price obtained per tree comes to Rs. 2–13. But each tree would yield about 25 cubic feet, say half a ton, so that the price obtained is equivalent to Rs. 5–10 per ton, or nearly as much as is usually got from the local traders for undersized teak logs.

Cost.

Total Production.

It would seem that the Burma production averages from 130,000 to 150,000 cwt. a year; the South Indian perhaps 1,000 cwt.; the Bombay perhaps half that quantity; and it is probable that Bengal and the United Provinces yield between them about 20,000 cwt. This conception of the probable annual production is inferred very largely from the returns of Foreign, Coasting and Internal Trade, rather than from actual statistics, and consequently it ignores local consumption. Thus the total exports to foreign countries were 183,729 cwt., valued at Rs. 36,96,106, in 1895–6; 122,082 cwt. in 1896–7; 97,187 cwt. in 1897–8; 61,669 cwt. in 1898–9; but they rose again to 127,815 cwt., valued at Rs. 24,70,422, in 1899–1900; sank to 101,995 cwt. in 1900–1; and further to 66,162 cwt. in the year following. In 1902–3 there was a slight improvement to 70,305 cwt., valued at Rs. 13,42,583, and a still further improvement in 1903–4, viz. to 112,936 cwt., valued at Rs. 19,71,896. In 1904–5, however, they again fell to 62,562 cwt., valued at Rs. 9,71,041, and in 1906–7 to 97,269 cwt., valued at Rs. 15,92,561. The traffic thus fluctuates greatly, but would seem on the whole to be declining. Usually Burma contributes about 98 per cent. of the total. For example, taking the total export for 1906–7, Burma furnished 95,451 cwt., Bengal 1,687 cwt., Madras 124 cwt., and Bombay, 7 cwt. The Bengal trade seems for some years to have declined and direct shipments from Burma to have increased. The United Kingdom is the country to which by far the largest consignments are usually made. The next in order are, as a rule, Egypt and either France, Germany or Holland. The trade with the Straits Settlements has steadily declined from 6,585 cwt. in 1898–9 to 1,796 cwt. in 1901–2, 104 cwt. in 1905–6, but rose to 854 in 1906–7. The United Kingdom takes from 70 to 80 per cent. of the total annual supply. Of the coastwise traffic Bengal (Calcutta) is the most important receiving centre and Burma the most important exporting. In 1895–6, Bengal received 35,079 cwt., but that traffic seems to have declined seriously, and in 1902–3 was only

Fluctuations.

Gum

13,557 cwt., and in 1905-6, 10,678 cwt. The Rail and River-borne trade returns show Bengal as the most important receiving province, and mainly from the town of Calcutta, hence doubtless Burmese. The United Provinces might be called the most important exporting centre, the major portion of the supply going to Bombay town and Presidency.

D.E.P., i., 44. Rita or Soap Pod.

A. concinna, *DC.; Fl. Br. Ind.*, ii., 296. A common prickly scandent bush met with in tropical jungles throughout India.

Since the pods of this bush are extensively used as a detergent, they are often confused with the Soap Nut (***Sapindus Mukorossi***), and, indeed, they bear, as a rule, the same vernacular names—viz. *rita* or *ritha*, but are sometimes separately distinguished as the *ban* (wild), *ritha*, *sikakai*, *ailah*, etc. These detergent pods are largely employed in washing silk and woollen goods. Some of the best tinctorial results are believed to be obtained only with yarn washed with this form of soap previous to being dyed. They are extensively used in washing the hair, and with much advantage in cleansing tarnished silver plate. In Northern Bengal they are utilised in poisoning fish. The trade in detergent pods must be very considerable in India as a whole. Collective returns are, however, not available, but we read of from 10 to 135 tons being imported into Bombay annually, and mainly from South Kanara. The *Madras Mail* (Jan. 1898) speaks of the local supply coming from Palghat and Vaniembaby, and urges that an effort should be made to place these pods on the European market.

Polishing Silver Plate.

Trade.

The bark of this bush is to some extent used as a Tan for fishing-lines, and is imported for this purpose into Bombay from Kanara. [*Cf.* Gamble, *Man. Ind. Timbs.*, 1902, 291; Cooke, *Fl. Pres. Bomb.*, i., 450.]

D.E.P., i., 48-50. Cassie Perfume.

A. Farnesiana, *Willd.; Fl. Br. Ind.*, ii., 292. A small tree best known in Europe as the Cassie Flower, and curiously enough is in India denoted by comparative or descriptive names such as *wilayati* (English) *babúl or kikar*, *pissi-babúl*, *gú-kikar*, *kankar*, *vedda vala*, *gaya-babúl*, *murki tumma*, *naga tumma*, *kusturi*, *jáli*, *nanlôngyaing*, etc. It is indigenous in America and possibly cosmopolitan in the tropics, is cultivated or naturalised all over India and Burma.

It is largely grown in France on account of the rich Perfume obtained from the flowers. Although it yields a Gum and other products similar to most species, the chief interest centres in its "Cassie Flowers." The late Sir F. Abel, in a letter to the Government of India, dated July 16, 1894, gives certain interesting particulars regarding the success obtained by a tea-planter in Naini Tal, in producing Cassie Pomade. Although a good deal of attention has been given to this subject, little progress has as yet been made towards establishing a trade in the perfume. It is probable that in India a difficulty might be found to exist in preventing the lard or sweet oil, employed in the manufacture of the pomade, from becoming rancid. But in the lower hills or terai where this tree abounds, or might easily be cultivated, it seems possible that a useful auxiliary crop to tea, coffee or even indigo planting, might be found in Cassie Pomade. [*Cf.* J. C. Sawer, *Odorography*, 114-6.]

D.E.P., i., 51.

A. Jacquemontii, *Benth.; Fl. Br. Ind.*, ii., 293. A small handsome shrub with polished stems and thorns, and flowers sweetly scented. It is met with in the North-West Himalaya up to 3,000 feet. In the Panjáb plains, in Sind, in Rajputana and in North Gujarat it is often very abundant, especially within watercourses.

Known in Afghanistan as the *hanza*, in the Panjáb it appears to bear, as a rule, the same vernacular names as ***A. arabica***, but a sample recently received from Amritsar, by the Reporter on Economic Products, bore the vernacular names of *dhakki* and *chota-kikar*. In Rajputana it is called *baonli* or *gulli bonli*; in Gujarat it is the *ráta-bával*; in Baluchistan *harbarbara*; and in Sind *khunbut*. Captain M. A. Tighe, Political Agent, Southern Baluchistan, speaks of the gum of this tree as one of the spurious gum arabics which are known in that country as *khorikhor*. [*Cf.* Rept., dated March 14, 1898.]

For some years past a considerable trade from Baluchistan and Sind has been done in the GUM of this species, exported from Karachi. Stokes (speaking of Sind many years ago) says that it is inferior to gum arabic, but is used in medicine, calico-printing, and in paper-making. Captain Tighe has much to say as to the difference between this and the true gum arabic (the *khor-ka-khor*) which see under ***A. senegal.*** But it may be added in conclusion that Messrs. Rowntree & Co., Ltd., of York, have pronounced the Amritsar samples (mentioned above) as the best of the series of Indian gums examined by them, for the confectioner's requirements. "It is strongly mucilaginous and forms a thin jelly on standing with ten proportions of water. The solution is brownish, but fairly free from sediment, and the flavour is sweet." It has been ascertained that about 35 cwt. of this are annually procurable in Amritsar.

Gum.

Suitable for Confectionery.

A. leucophlœa, *Willd.; Fl. Br. Ind.*, ii., 294; Gamble, *Man. Ind. Timbs.*, 295; Brandis, *Ind. Trees*, 265. The *safed kikar, arinj, rinj, rerú, nimbar, goira, hewar, haribaval, vel-vellam, tella-tuma, tanaung.* This large deciduous fast-growing tree is found in the plains of the Panjáb and Rajputana, the forests of Central and South India and Burma. It prefers a low-lying situation, and in the Panjáb its presence is regarded as significant of a rich soil. Its branches are often disfigured by large excrescences.

D.E.P., i., 52.

According to Mr. J. G. Prebble, it yields a GUM readily soluble in water, which forms a good thick pale-coloured mucilage, possessed of the somewhat peculiar property of being gelatinised by borax but unaffected by ether, neutral or basic acetate of lead or perchloride of iron. It seems probable that, owing to its close chemical affinity, this gum is often largely used to adulterate the better qualities of "Gum Ghati" (see p. 17) of commerce. According to Mr. Hooper (*Agri. Ledg.*, 1902, No. 1, 26) a specimen of the bark sent from the Province of Mysore was found to contain 20·8 per cent. tannin, being equal to the best *babul*-bark; but this seems to have been an exceptional case, as he adds that a sample examined at Dehra Dun yielded only 9·33 per cent. Its use as a TAN is therefore doubtful. The bark affords a strong FIBRE said to be much valued for fishing-nets. Ground to a powder it is sometimes eaten with *bajra*, especially in times of scarcity. But it has obtained a considerable reputation as an astringent used in alcoholic DISTILLATION. On this account it is often called *sharab-ki-kikar* (spirit Acacia). The tannin precipitates the albuminous substances present in the saccharine juices, and thus facilitates fermentation, but is also said to give a pleasant astringent flavour to the beverage. In the Southern Maráthá country the trees are farmed out by Government, in consequence of the value of the bark. A distiller in South India recently informed me that he would use this bark more extensively than at present, were it possible to obtain a guarantee of quality. He held that while most Acacia barks might be employed in fermentation, that of the present species was so much superior to all others as to justify its being called "The Distiller's Acacia." [*Cf.* Cooke, *Fl. Pres. Bomb.*, i., 447.]

Gum.

Fibre.

Distillation.

A. modesta, *Wall.; Fl. Br. Ind.*, ii., 296; Gamble, *Man. Ind. Timbs.*, 299; Brandis, *Ind. Trees*, 266. The *phula, phulái, bhamburi, kantosirayo, palosa.* A moderate-sized tree found in the Suliman and Salt Ranges, the Sub-Himalaya—between the Indus and Sutlej—and is one of the characteristic trees of the Northern Panjáb plains. It grows readily in poor sandy or rocky soils, but curiously enough is also found occasionally in very damp situations. It is a slow grower, and in consequence is not often planted, except as a fence, for which it is peculiarly suited.

D.E.P., i., 52.

It yields sparingly a very useful GUM which occurs in small round tears or angular fragments, with a few vermiform pieces marked with waved transverse lines. Prebble says, "It is translucent and of a yellowish colour; very soluble in water, forming a good pale-coloured mucilage. With basic acetate of lead and ferric chloride it forms a jelly, but not with borax; with neutral acetate of lead a faint precipitate or cloudiness, and a slight reduction with Fehling's solution." The gum is sent to Bombay from Northern India, and is classed by the merchants as "Amritsar Gum." The Panjáb supply comes mainly from the Rawalpindi and Jhelum districts. In Northern India it is largely

Gum.

Used in Medicine.

employed in medicine. The tree affords also a very beautiful, strong and durable TIMBER which is largely employed for cart-wheels, sugar-cane crushers, agricultural implements, etc. The soft delicate twigs are employed as tooth-brushes, especially in the Panjáb. [*Cf. Pharmacog. Ind.*, i., 552.]

D.E.P., i., 54.
Habitat.

A. pennata, *Willd.; Fl. Br. Ind.*, ii., 297; Gamble, *Man. Ind. Timbs.*, 300; Brandis, *Ind. Trees*, 269; Cooke, *Fl. Pres. Bomb.*, i., 451. *Biswul, arar, shemba, aila, undaru, gurwa, afla, awal, arfu, su-yit*, etc. A large climbing shrub of the Sub-Himalaya, East Bengal, South India, and common all over Burma.

Tanning-bark.

The bark is an article of commerce, being exported from the Konkan, and employed in Bombay to TAN fishing-nets. Hooper (*Agri. Ledg.*, 1902, No. 1, 26) says that a sample from Bombay was found to possess only 8·8 per cent. of tannin. In the Annual Reports of the Forest Department, Bombay Southern Circle, an entry occurs of the amounts realised by the sale of *shemba* bark. These range from Rs. 25 to Rs. 394. In Bombay it fetches about Rs. 14 per 700 lb.

D.E.P., i., 55.
Gum Arabic.

A. Senegal, *Willd.; Fl. Br. Ind.*, ii., 295; Gamble, *Man. Ind. Timbs.*, 299; Brandis, *Ind. Trees*, 266; Cooke, *Fl. Pres. Bomb.*, i., 449. It yields the TRUE GUM ARABIC of European commerce, and is the *khor* (Sind), *khor-ka-khor* (Lus Bela), *kúmta* (Rajputana). A low tree with grey bark and flexuose branches, met with, so far as India is concerned, on the dry, rocky hills of Sind and Rajputana, more particularly in the Lus Bela country.

hree Forms.

Commercial Qualities.—It seems desirable to bring together in this place a few of the more important facts regarding India's participation in the world's supply of Gum Arabic. There may be said to be three chief forms of the gum: 1st, TRUE GUM ARABIC of EUROPEAN COMMERCE; 2nd, THE EAST INDIA GUM ARABIC; 3rd, THE GUM ARABIC of INDIA, often collectively called "Gum Ghati." The True Gum Arabic is obtained from *A. senegal, Willd.*, and there may be said to be two or three grades of it:—

I. (*a*) GUM SENEGAL, the *verek* of the Negroes.—This comes from the French Colony of Senegal (on the West Coast of Africa).

(*b*) KORDOFAN or TURKEY GUM.—This is known in East Central Africa by the name *hashab*. It comes from the mountainous tracts of Kordofan on the Upper Nile and almost in the same latitude as Senegal, though across the vast continent of Africa from west to east. It occurs in round lumps, often as large as a walnut, or in irregular broken pieces, pure white, very much fissured, especially on the surface. This gum is most frequently used for medicinal purposes, and may, in fact, be regarded as the true official Gum Arabic of England, India and America.

Medicinal Gum Arabic.

(*c*) Inferior qualities known in trade, such as SUAKIM GUM, SENNAAR, BLUE NILE, BARBARY or MOROCCO and MOGADOR GUMS. These are most probably mainly derived from ***A. arabica.*** Reference has already been made to the variability of gum due to climate, soil, seasons, etc., and to the part possibly played by *bacilli* (see above, p. 2), but physical changes also take place subsequent to its collection, and these doubtless produce variations in quality. [*Cf. Journ. Soc. Chem. Indust.*, 1903, xxii., 429; Goetze, *Pharm. Zeit.*, 18, 119; *Pharm. Journ.*, 1903, 70, 417; Muriel, *Ind. For.*, 1902, xxviii., 45-58.]

East Indian Gum.

Attention may now be directed to The EAST INDIA GUM ARABIC. This is imported into Bombay, in the first instance, from Aden and the Red Sea ports—no part of it being produced in India. There are two qualities, viz. *maklai* and *maswai*. The former exists in large round tears or vermicular pieces, white, yellow or reddish. It is much like GUM SENEGAL, but more fissured. It derives its name from Makalia, the port from which it is mainly shipped. The latter exists in angular fragments and vermicular pieces very similar to the former and obtains its name from the port of Massowa. Both of these are good soluble gums, very little inferior to true Gum Arabic. They are picked and assorted, then re-exported from Bombay as EAST INDIA GUM ARABIC, the traffic being by no means unimportant. Within recent years, however, that traffic has given distinct evidence of decline, due very possibly to direct shipments to Europe in place of to Bombay—the historic emporium of distribution.

Gum Ghati.

Lastly, we come now to the INDIAN GUM ARABIC or GUM GHATI. It would seem that, in contradistinction to the gums that reach Bombay by sea, those that come by train, down the Ghats to Bombay, are collectively designated GUM GHATI. But it may be here mentioned that Clusius in 1605 speaks of Gummi Gutti as brought from China to Europe: hence it may be asked, is it the Malay *getah*? [*Cf. Kew Mus. Guide*, 1907, 150.] Accepting the modern usage, "Gum Ghati" would embrace very possibly a wide range of gums, and very often, it is feared, degrees of quality denote the extent of admixture rather than the nature of specific variation. Gum when detected is gathered casually by women and children, or by the shepherds, and sold in small quantity to the nearest shopkeeper. It is next conveyed to the dealers and so on through many hands until diversified gums, the produce of a wide area, get hopelessly intermixed. Nowhere in India is gum systematically produced, and indeed hardly anywhere is arborescent vegetation so exclusively of one gum-yielding tree as to admit of a large uniform and constant supply of any particular gum.

Quality.

Indian Method of Collection.

Difficulties in Trade.

Prebble (in the paper to which reference has already been made) describes 27 gums as met with by him in Bombay. These include ***A. arabica, A. Catechu, A. Farnesiana, A. leucophlœa*** and ***A. modesta.*** Some short time ago Captain M. A. Tighe, Political Agent, Southern Baluchistan, was induced to give attention to this subject. In consequence he furnished admirable samples of the gums of Baluchistan, as also corresponding botanical specimens of the plants from which these had been procured. The two most important were thus definitely determined, namely, *khor* (or *khor-ka-khor*)—***Acacia senegal,*** and *harbarbara*—***A. Jacquemontii.*** Tighe's description of the country, of the season of flow of gum, and the dependence on rain, will recall the conditions that prevail in the regions where the True Gum Arabic is produced. [*Cf. Agri. Ledg.*, 1902, No. 2, for further particulars.] Far to the south, at Tuticorin, a modern trade in gum has been organised. Considerably different prices are being paid for the various grades of it, and at least one firm employs a staff of persons to hand-pick and assort the gums as procured. I was unable to ascertain all the species of plants that afford these South Indian gums, but the most important would doubtless be ***A. Sundra,*** which is the South Indian variety of ***A. Catechu*** and an abundant tree from Coimbatore northwards to the Deccan and Gujarat. [*Cf.* Heuzé, *Les Pl. Indust.*, 1895, iv., 258–66.]

Bombay Gums.

South Indian Gum.

Trade in Gum.

TRADE IN GUM ARABIC.—As already stated, one of the features of this trade is the supply drawn by India from Africa, Arabia, etc., by sea, and from certain tracts of country by land routes across the frontier. There are thus exports from India in both Indian and foreign gums, the latter being usually designated re-exports. The following statement shows the total transactions under these headings:—

(*a*) *IMPORTS* by SEA 1898–9, 2,841 cwt., Rs. 59,531; 1902–3, 1,146

Decline in Price.

cwt., Rs. 21,494; 1906–7, 10,127 cwt., Rs. 1,54,270: (*b*) by LAND 1898–9, 18,093 cwt., Rs. 282,877; 1902–3, 12,800 cwt., Rs. 1,66,066; 1906–7, 11,969 cwt., Rs. 1,56,932: (*c*) *RE-EXPORTS* 1898–9, 7,297 cwt., Rs. 1,05,801; 1902–3, 10,704 cwt., Rs. 1,47,044; 1906–7, 2,684 cwt., Rs. 57,417: (*d*) *EXPORTS* 1898–9, 41,469 cwt., Rs. 7,14,632; in 1902–3, 38,019 cwt., Rs. 4,54,639; and in 1906–7, 35,202 cwt., Rs. 6,69,263. In 1895–6 the exports were less in quantity, but nearly twice the price of those in 1902–3. If there be any meaning in averages of declared official values in a traffic that for some years has been obviously changing its main characteristics, it may be affirmed that a marked depreciation in price has taken place.

Adulteration.

Temporary Increase in Price.

Increased Indian Production.

The traffic in Indian-produced gum for 1906–7 may now be analysed thus—exports from Bombay 35,044 cwt. and from Sind 51 cwt. The re-exports take place almost entirely from Bombay, and they are far in excess of the recorded imports, both by sea and land routes. It is not known to what extent the Trans-frontier traffic could be accepted as being gum arabic, but the chief items of the "gums and resins" carried across the frontier, drain from Nepal and Lus Bela. The latter seems a modern trade, and doubtless mainly in the gum here dealt with. The discrepancies between the returns of imports and of re-exports are seemingly due to the Trans-frontier land supply not being fully accounted for; to the varying extent to which stocks are drawn upon or withheld; and lastly very possibly to admixture with Indian gum arabic. The re-export trade fluctuates both in quantity and value very considerably, having undoubtedly in the past been greatly disturbed through war and plague. But on this subject Wordehoff (*Journ. d'Agri. Trop.*, 1901, i., 46) affirms that the advance in price of the gum called "Soudan" only lasted into 1892, and that since 1894 the price has been almost the same as in 1880. Vilbouchevitch believes that the only effect of the Soudan troubles has been to bring into notice, for subsidiary purposes, certain gums not previously known or indifferently appreciated. There seems no doubt, however, that so far as India is concerned, a decline has taken place in the imports from Red Sea ports, but an expansion of Indian supply, more especially through the organisation of the Sind and Madras contribution.

The figures discussed above are mainly those given for Gum Arabic, not the "other Gums" nor the "Resins." Moreover an error is ever present in that it is not always possible to isolate returns of gums from those of resins. The "other gums" may also be to some extent "gum arabic," and thus the figures quoted may not represent the total trade.

D.E.P.,
i., 60.

A. Suma, *Buch.-Ham.*; *Fl. Br. Ind.*, ii., 294; Gamble, *Man. Ind. Timbs.*, 295; Brandis, *Ind. Trees*, 268.

This medium-sized tree has a white bark (a circumstance that gives origin to most of its vernacular names); it is common in Bengal, Bihar, Assam and South India, from the Karnaták to Mysore. It is known as the *sai-kanta, kumtia, dhaula* (*white*) *khejra*, etc. Through being confused with *var.* ***Sundra*** (which see under **A. Catechu**, p. 9) it has by some writers been incorrectly spoken of as a cutch-yielding species.

D.E.P.,
i., 84-98.

ACONITUM; *Fl. Br. Ind.*, i., 27–9; *Agri. Ledg.*, 1896, No. 32; 1898, No. 3; 1902, No. 3; Brühl, *Ann. Roy. Bot. Gard. Calc.*, 1896, v., pt. ii., 109-14; Stapf, *Ann. Roy. Bot. Gard. Calc.*, 1905, x., pt. ii., 115-94; Monk's-hood; RANUNCULACEÆ.

There are in the world perhaps 150 species of Aconites, chiefly inhabitants of the north temperate regions, 24 being Indian. These were figured and described by Brühl and more recently monographed and beautifully illustrated by O. Stapf of Kew. Simultaneously extensive local investigations into the Indian production and utilisation of the Commercial Aconites have been conducted during the past ten years or so by the Director-General of Botanical Survey and by the Reporter on Economic Products to the Government of India (ably supported by numerous correspondents and contributors). It was a fortunate circumstance also that the co-operation of Prof. W. R. Dunstan of the Imperial Institute, London, was at the same time secured. The researches which he and his collaborators have made, into the chemical composition of the various roots, supplied by the Indian authorities (as far as possible in a parallel series with the botanical samples sent to Kew), may be truly spoken of as having revolutionised our knowledge of the chemistry and medicinal properties of the Indian Aconites. [*Cf.* Cash and Dunstan, *Phil. Trans. Roy. Soc. Lond.*, 1898, cxc., 239; cxcv., 39-97; also *Proc.*, 1901, 68, 384-9; *Imp. Inst. Tech. Repts.*, 1903, pt. ii., 40-91; Dunstan and Andrews, *Trans. Chem. Soc.*, 1905, 87, 1620-50; also Dunstan and Henry, lxxxvii., 1650-56.]

Recent Researches.

The area of Indian distribution may be described as extending from Afghanistan, Baluchistan, Hazara, Kashmir, Kumaon, Nepal, Sikkim and Bhutan to the mountains of Assam, Manipur, and Burma. But on the mountains of Central, Western, and Southern India no representative of the genus occurs. While these interesting plants are thus confined to the lofty mountainous tracts that skirt the geographical frontier of India, few drugs are more frequently present or more generally understood by the rural drug-dealers—so far as such knowledge goes—than are certain forms of the genus ***Aconitum***. In fact it might be said that the Aconites are very much more extensively used in India than in Europe and America. But perhaps the most poisonous forms are more largely employed in India as animal poisons—if one might not say as criminal poisons—than in medical practice. This circumstance thus enhances the interest and value of the recent researches. For example, the Hemp Drugs Commission in their Report (1893-4, 157) mention that aconite is often mixed as an adulterant with Indian hemp in the preparation used as a beverage. The particular species so employed is not stated, and the circumstance is mentioned as being of interest in cases of poisoning from *bhang* indulgence. For these and such-like reasons it has been recognised for some years past as an imperative necessity to be able readily and with certainty to distinguish at least the chief qualities of Indian aconites. In other words it has been thought that all that was needed to develop a regular and satisfactory trade in Indian aconite (and to be able to control and supervise such traffic if need be) was definite knowledge of the chief forms that exist and the regions from which these are severally derived.

Distribution.

The inquiry recently conducted has resulted in the establishment of four forms, or rather groups of forms, of aconite, as being extensively traded in all over India, and to some extent regularly exported to foreign countries. But above all, the discovery that not one root but many constitute the Nepal Aconite of commerce is a conclusion of the greatest practical value, which is heightened in its significance when it is added that very possibly none of the roots sold as such are derived from the true ***A. ferox***, *Wall.*, of botanists, which in works on Materia Medica has hitherto alone been spoken of as the Nepal Aconite plant. The four forms may be expressed commercially as follows:—

Commerce.

I. Non-Poisonous forms, the active principles of which are either *Atisine* or *Palmatisine*. The Aconites that may be placed in this position are:—

A. heterophyllum, *Wall.*; Stapf, *l.c.* 151-4; *Fl. Br. Ind.*, i., 29; Royle, *Illust. Him. Bot.*, 1834, 56, t. 13; *The Bower Manuscript* (Hoernle, transl.), many passages. A common plant on the sub-alpine and occasionally alpine Himalaya from the Indus to Kumaon.

D.E.P., i., 91-4. Atis.

This is the ***atis, ativika, patis***, etc. (Sanskrit ***ativisha***, which might be rendered "antidote"), but in the more eastern section of its area it receives the name ***nirbisi***—a name more correctly indicative of ***A. palmatum***. ***Atis*** root, if of good quality, should break with a short starchy fracture and present a uniform milky white surface. The fresh fully grown root is about 1 to 1½ inches long, and perhaps half an inch thick at its upper extremity. In structure it is of a uniform white farinaceous substance within; transverse sections seem to consist of four, or sometimes five, isolated cambium strands, the vessels of which show prominently the radiating wedge-shaped formation.

Inert.

The discovery made by Dr. H. A. D. Jowett that the alkaloid exists in very small proportions, destroys any chance for the drug in the future; and the still more recent opinion that it is inert, has no antiperiodic virtue (arrived at by the expert Committee appointed by the Government to investigate the Indigenous Drugs of India), renders it necessary to remove the root from consideration as a drug, except as a mild bitter tonic. Several European and Native merchants and chemists furnished me with parcels of the roots of ***A. palmatum*** under the name *atis*, and others of the true *atis* largely adulterated with ***A. palmatum***. These facts may be accepted as showing that in Indian pharmacy the two roots are regarded as similar, if not identical in properties. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 8.]

D.E.P., i., 98. Bikma.

A. palmatum, *D. Don.;* Stapf, *l.c.* 156–8; *Fl. Br. Ind.*, i., 28 (*excl. syn.*); *Agri. Ledg.*, 1902, No. 3, 89. A species met with in the alpine Himalaya of Nepal, Sikkim, and South Tibet, at altitudes of from 10,000 to 15,000 feet.

This is best known by the names *bikma, bishma, wakhma, vakhma,* and *nirbisi.* In Sikkim (according to Mr. C. Gilbert Rogers) it is the *seto-bikhuma* (or white *bikhuma*, the black *bikhuma* being ***A. laciniatum***). The word *bikhuma* or *bikhma* might be translated "resembling-*bikh*," but also has the meaning of non-poisonous *bikh.* So also *nir-bish* means free from poison (*bish*). It seems probable that while that is the meaning of *nirvíshi*, the word often confused with it—*nirvísha*—denotes an antidote to poison. The *nirvísha* most quoted by writers is the substance separately designated *jadvar.* The late Dr. Moodeen Sheriff paid much attention to the subject of the *jadvars* of modern Indian pharmacy, and one at least of those he described would seem to be the root of ***A. palmatum***. It has come to me from all parts of India broken into short lengths and often bearing the name *jadvar.* What the *nirvísha* or *jadvar* of the Ancients may have been is a subject beyond the scope of this work.

Jadvar.

As met with in commerce *bikhma* root is pale-brown; it exists for the most part in long straight pieces, sometimes twisted together, but is never completely pyramidal. The fragments range from 1 to 3 inches in length and ¼ to ½ inch thick. In structure they are almost pure white, are of a starchy consistence and, on tranverse section, show a double ring of large though inconspicuous cambium strands in the form of circular or horseshoe-shaped patches. It is perhaps the most easily recognised of all the Indian commercial aconite roots.

The alkaloid present in this root has been found identical with that of ***A. heterophyllum***, and it is thus impossible to put faith in its reputation as an antidote for poison. But according to Dutt, the Sanskrit name for ***A. heterophyllum*** is *ativisha* or *ataicha*, a circumstance if correct that would confirm the identical properties of *atis* and *bikhma.*

D.E.P., i., 96.

A. rotundifolium, *Kar. et Kir.;* Stapf, *l.c.* 149–51; *Fl. Br. Ind.*, i., 29; also **A. violaceum,** *Jacq.;* Stapf, *l.c.* 144; *A. multifidum, Royle, Illust. Him. Bot.*, 45, 56; *A. dissectum, Madden, Journ. As. Soc., Beng.*, 1846, xv., 95 (*non D. Don*); *A. Napellus, var. multifidum* and also *rigidum, Fl. Br. Ind.*, i. 29.

These pretty little Alpine aconites are characteristic of the Western Himalaya (along with ***A. heterophyllum***) between the area of the poisonous forms of the East and Central Himalaya and that of the poisonous forms which reappear on the extreme West. They have no commercial value, though in the Panjáb these roots are occasionally seen in the drug-shops, and appear to be known as *tilia kachang* or *dudhia.* They can with difficulty be distinguished from the roots of ***A. heterophyllum***.

II. Poisonous Aconites that contain *bikhaconitine* (in one species) and *pseudaconitine* (in some at least of the others). These roots are in India traded in under the names "Nepal Aconite," *bish, bikh,* etc. [*Cf.* Herbert, *Travels*, 1677, 369.] They can very appropriately, therefore, be collectively designated as the East Himalayan Aconites, for although one species exists in Kunawar and two in the mountains of Assam and Manipur, their headquarters commercially are Sikkim and Nepal. They are the Nepal Aconites of the shops of Calcutta. The important forms of the series are :—

A. Falconeri, *Stapf, l.c.* 163–5 ; *A. ferox, Royle, Illust. Him. Bot.*, 47 (in part) ; *Fl. Br. Ind.*, i., 28 (in part).

This plant occurs in the sub-alpine and alpine Himalaya of Garhwal, and a well-marked variety of it (which Stapf calls ***latilobum***) was collected by Mr. Minniken in Nagli, Bashahr, where it is known as *kalamohra* (or the very poisonous *mohra*).

A. laciniatum, *Stapf, l.c.* 168–9 ; *A. ferox, var. laciniata, Brühl, l.c.* v., pt. ii., 11 (in part) ; *Agri. Ledg.*, 1902, No. 3, 96.

Sikkim Aconite.

This plant comes from the sub-alpine and alpine Sikkim, where it is called (so Rogers informs us) *kalo-bikhuma*—a name that doubtless would mean the poisonous *bikhuma*, in contrast with the non-poisonous *bikhuma* (***A. palmatum*** above). This isolation of ***A. laciniatum*** from the true *bikh* is interesting and important. It shows that it is recognised locally as only a substitute or adulterant for the true root, and in fact it would seem to be exclusively so used. Apparently it is the *kalabachnag* of Moodeen Sheriff, and very possibly the *kalakut* of other writers. The root is if anything larger than the most prevalent "Nepal Aconite" of Sikkim (***A. spicatum*** below) and has numerous circular scars, indicating fallen lateral roots, so abundant and regular as to resemble nodes or joints. In transverse section the tuber seems to differ from that of ***A. spicatum*** by the absence of the so-called inner ring of vascular strands enclosing the pith.

A. lethale, *Griffith;* Stapf, *l.c.* 175–6 (the Mishmi Aconite) ; and **A. nagarum,** *Stapf, l.c.* 176–7 (the Naga hills and Manipur Aconite). It is probably safe to regard these as the most eastern members of the series.

Stapf views the aconite of the Akhas as being very possibly the true ***A. spicatum.*** [*Cf.* Lewin, *Arrow-poisons*, in Virchow, *Archiv. Path. Anat. und Phys.*, 1894, 138, 289.]

A. spicatum, *Stapf, l.c.* 165–8; *A. ferox, var. spicata,* also *var. crassicaulis, Brühl, l.c.* v., pt. ii., 110 ; *A. ferox, Fl. Br. Ind.*, i., 28 (in part) ; *Agri. Ledg.*, 1902, No. 3, 94–6 (in part) ; and later by Dunstan and Andrews, *Trans. Chem. Soc.*, 1905, lxxxviii., 1636–50. This is the most abundant, most robust, and most characteristic species of alpine Sikkim and Chumbi.

D.E.P.,
i., 87-91.
Nepal
Aconite.

The chief "Nepal Aconite" of Indian commerce, the *bikh, bish,* the *ativasa* (very poisonous *bish*) of Sir Walter Elliot ; the *mitha-bish, sringi-bish, dagru, bachnag,* or *talia* of Indian writers, and the *singia jur* or *singia khar* of *Taleef Shereef* (Playfair, transl.), 1833, 107. Its poisonous principle has been called *bikhaconitine* by Dunstan and Andrews, and described as closely related to *pseudaconitine* both in its chemical properties and physiological action.

The roots are very large, and when fresh are soft, flexible and pale-coloured, but when quite dry they are hard, dark brown or black externally, and of a brownish-red internally. The half-dry root when cut resembles horn (hence the name *singyi* or *singya-bis*), but as it matures and dries it becomes hard and has darker-coloured portions developed as embedded irregular patches within the tissue. These patches often appear like resin in consistence. In transverse section Stapf says the tubers are seen to possess cambium strands, continuous and forming a more or less sinuous ring. The secondary sieve-strands of the mother tubers are not encased in sclerenchymatic sheaths. The samples examined by me might perhaps be properly described as having the vascular strands in the form of an irregular sharply pointed star, enclosing a small central pith surrounded by a secondary ring of bundles. To protect the roots from

Method of Preservation.

being weevil-eaten they are often preserved in cow-urine. This may account for the dark colour of some parcels, and may perhaps explain the name *kala* (black) often given to these, though most writers seem to prefer to translate *kala* when given to an aconite as meaning deadly. This is the root exported from both Nepal and Sikkim to Calcutta. It has been pointed out that Nepalese traders have been in the habit of draining their supplies from the Sikkim as well as the Nepal side of the Singaleelah range, but that recently the facilities of the Himalayan Railway at Darjeeling have begun to make the Sikkim supply by far the most important. As indicative of the very poisonous nature of this plant, mention may be made of the fact that the sheep have often to be muzzled in the Sikkim Terai. [*Cf. Kew Mus. Guide*, 1907, 9.]

III. Poisonous Aconites, one at least of which contains *pseudaconitine*; they are in Northern and Western India traded in as "White *Bikh*," *safed-bikh, safed-bachnag* or some derivative of the word *mohra* (a word which like *bikh* denotes a deadly poison). They also constitute grades of the so-called "Nepal Aconite" of Indian commerce, and are the Central Himalayan Aconites, those found in the shops of Upper and Western India.

A. deinorrhizum, *Stapf, l.c.* 158-60; *A. ferox, var. atrox, Watt, Agri. Ledg.*, 1902, No. 3, 97 (in part).

Bashahr Aconite.

This interesting plant was collected in Bashahr (Jani Kanda) by Mr. Minniken and said to bear the local name of *mohra*, but it is believed by Stapf to have been very possibly the *maura bikh* of Cleghorn, the *mitha-dúdya* of Aitchison (*Trade Prod. Leh*, 175), and the plant referred to by Madden (*Journ. As. Soc. Beng.*, 1846, xv., 95). It is thus very possibly met with throughout the Central Himalaya from Kunawar to Nepal, and has been collected by Mr. Duthie in many parts of Kumaon. Moorcroft spoke of the abundance of aconite (possibly this species) in Kumaon, and supposed the stupefiant effects of the honey from certain localities to be due to the bees feeding on aconite. Dunstan and Andrews on the examination of fresh, more accurately determined roots, have arrived at the conclusion that the present species is that which should be regarded as affording the alkaloid *pseudaconitine* of previous reports. The existence of that alkaloid in certain forms of Indian aconite appears to have been first made known by Schott (1857), elaborated by Hübschmann (1868), and worked out in every detail by Dunstan and Carr (*Trans. Chem. Soc.*, 1897, reprinted in *Agri. Ledg.*, 1897, No. 19; 1898, No. 3). These distinguished chemists give full particulars of the properties of the alkaloid and its decomposition products. It would appear that *pseudaconitine* may physiologically be regarded as identical with *aconitine*, though very much more active. The chief objection to its extended use is the difficulty of obtaining a continuous supply of the root of uniform quality. It seems, moreover, probable that this plant is not separately recognised by the collectors of and dealers in drugs, but is confused with the following:—

Poisonous Honey.

A. Balfourii, *Stapf, l.c.* 160-3; *A. ferox, Wall., Pl. As. Rar.*, i., 35 (in part); Balfour, in *Edinb. New. Phil. Journ.*, 1849, xlvii., 366, t. v.

This corresponds with a large portion of the ***A. ferox**, var. **atrox**, Watt* (*Agri. Ledg.*, 1902, No. 3, 97-8), and includes also ***A. ferox** var. **polyschiza**, Brühl.* It is met with in the sub-alpine and alpine Himalaya of Garhwal to Nepal, and seems to be known by the vernacular names *gobriya* and *banwa* or *bhanwa*. At present it is doubtful how far the following names belong to this species or to ***A. deinorrhizum**: phatikia, kawriya, diliya, dhanla, dhumuriya, jhirina*, etc. Mr. Duthie observes that every valley has its own names for its aconites, and even different names for the same plant when of a different shade of colour.

Garhwal Aconite.

The difference between the roots of ***A. deinorrhizum*** and ***A. Balfourii*** is not very great. The latter is shorter and thicker than the former, and has always hardened sharp rootlets attached. The former is that which comes most largely into the markets of India as White Aconite, *safed-bikh, safed-bachnag.* According to Native opinion it is the most valuable and certainly the most expensive form in the bazárs. It was furnished to me under the name of

White Aconite.

"**A. Napellus**, *Linn.*," but it would seem that north and west of Cawnpore this is the *bikh* of the Indian drug shops, whereas south and east *bikh* would be **A. spicatum**. The white-*bikh* root is easily recognised : when dry it is brittle and white in section, has a farinaceous structure in some respects like that of *bikhma*, but it is distinctly poisonous and must, therefore, be carefully distinguished. It is usually about 2 or 3 inches long, broadest at its immediate extremity, and gradually and uniformly tapered to a long sharp point below. It is nearly always perfectly straight and the cuticle is of a chestnut-brown colour, smooth, though at the same time irregularly contracted into exceptionally large folds. In transverse microscopic section its roots are seen to have an interrupted ring of large cambium strands. These are either irregularly horseshoe shaped or elliptical and arranged round the pith, which frequently becomes cavernous. Occasionally also a few single cambium bundles are seen scattered throughout the fundamental tissue.

I understand that Prof. Dunstan has found, on analysis of a sample of white-*bikh* from Dudatoli, that daughter tubers contain nearly 1 per cent. and the mother tubers ½ per cent. of *pseudaconitine*.

Almora Aconite.

The plant which Brühl named as *var.* **polyschiza** was supplied by Mr. J. S. C. Davis of Almora. When received by me the samples bore the names *phutkia* (*fatkia*), and *gobaria*—names which recall some of those reported by Duthie as given in Garhwal. Recently Davis has obligingly furnished further material, as also a translation of a report which he had received from the political Peshkar at Garbyang. It would seem that at Garbyang, aconite root is designated *mitha* but that there are two forms, (*a*) *fatkia* and (*b*) *gobaria*. The former is a smaller and less poisonous plant than the latter. The roots furnished were found to have a white farinaceous structure with a single irregular ring of cambium strands.

IV. Poisonous Aconites that contain *indaconite*. This may be accepted as a series that corresponds botanically with the most valuable medicinal aconite of Europe and America—viz. **A. Napellus**. Stapf has shown that the true **A. Napellus** nowhere exists in India. The world's supply of medicinal aconite is, in fact, derived mainly from the cultivated plant, and comes very largely from Germany. But there are one or possibly two indigenous aconites met with in the extreme western division of the Himalaya and adjacent hills of the Panjáb that seem worthy of a place in this section :—

A. chasmanthum, *Stapf, l.c.* 142–4 ; *A. Napellus, var. spicatum, Duthie, Rec. Bot. Surv. Ind.*, i., No. 3, 37 (in part); *A. Napellus, Stewart, Pb. Pl.*, 1–2 ; Dunstan, *Agri. Ledg.*, 1897, No. 19, 377 ; *A. Napellus, var. hians, Goris*, in *Bull. Sc. Pharm.*, 1901, iii., 112 ; *A. hians, Watt, Agri. Ledg.*, 1902, No. 3, 101 ; also *dissectum, Watt, l.c.* 100 (in part) ; Dunstan and Andrews, *Contrib. to Knowledge of Aconite Alkaloids, Trans. Chem. Soc.*, 1905, 1620–36.

Kashmir and Hazara Aconites.

This very beautiful species occurs on the sub-alpine and alpine Himalaya from Chitral to Kashmir, and also on the mountains of Hazara, between altitudes of 7,000 and 12,000 feet. It is the *mohri* of Hazara ; *tilia, kachang, dudhia, piun* of the Himalaya, and *ban-bal-nag* of Kashmir. According to Dunstan and Andrews its roots contain *indaconitine*, an alkaloid which represents a compound intermediate between *aconitine* and *pseudaconitine*. Cash and Dunstan (*Proc. Roy. Soc.*, 1905, 468) have pointed out that its physiological action differs in degree only, and not in kind, from the two alkaloids just named. Samples have been furnished by Indian chemists and druggists as "True Aconitum Napellus." One contributor sent it under the name of *mitha zaher*. Davies (*Trade Report*) alludes to 20 seers of *mitha tilia* as annually exported from Peshawar to Kabul. Moodeen Sheriff mentions the circumstance that a very small and highly poisonous root is sold in Northern India but never seen in the south. It differs from that of **A. Napellus** by being smaller, shorter but comparatively thicker. The tubers are seen in cross-section to have the cambium continuous, forming a more or less sinuous or star-shaped ring. The remains of the stem are nearly always found on its upper extremity. It is not more than one inch or an inch and a quarter long. Is of a black colour; curved, densely coated with short sharp thorns (lateral rootlets), and is terminated by a short, hard, smooth and pointed beak. In the dry state it has a horny or cartilaginous fracture.

A. soongaricum, *Stapf, l.c.* 141–2; found in Gilgit.

Gilgit Aconite.

Of all the Indian forms of the genus this comes nearest botanically to ***A. Napellus**, Linn.* The root does not appear to find its way to the bazárs of India. This species has not as yet been chemically investigated, and it is just possible that it may be found to contain *aconitine.*

**D.E.P.,
i., 99-102.
Sweet-flag.**

ACORUS CALAMUS, *Linn.; Fl. Br. Ind.*, vi., 555; AROIDEÆ. The Sweet-flag, *bacha, shadgrantha, vashambu,* etc. The imported Persian rhizome is known as *bál-vach* or *bál-vekhand.* The medical treatise which constitutes *The Bower Manuscript* (Hoernle, transl.) makes repeated mention of this drug.

Oil.

It is the *Calamus aromaticus* of mediæval writers, and possibly the *Acoron* of the Greeks. It is a semi-aquatic herb occurring wild and sometimes cultivated, from Kashmir to Assam, Manipur and Burma, and to the mountains of Central, Western and Southern India. It is most abundant between altitudes of 2,000 and 6,000 feet. An essential OIL prepared from the leaves is used in England in the preparation of a hair-powder, and from 1·3 to 2·6 per cent. of a yellow neutral essential oil may be extracted from the rhizomes, which like the other parts of the plant owe their property to the *glucoside acorin.* Gildemeister and Hoffmann (*Volatile Oils* (written under the auspices of Schimmel & Co.), 302) say that though the oil has been repeatedly examined no satisfactory insight into its chemical nature has been obtained. It is used in "the manufacture of liquors and of snuff," but is less in demand than formerly for medicinal purposes. Native MEDICAL practitioners consider the rhizome in large doses an emetic, in small doses tonic or stomachic and carminative. It is prescribed in cases of fever, rheumatism and dyspepsia, as well as for flatulence, even in infants. It is also a pleasant adjunct to tonic or purgative medicines, and as an aromatic stimulant is recommended for catarrh and distressing coughs. Dr. Childe, Second Physician to the Sir Jamsetji Jijibhai Hospital, Bombay, tried an authentic tincture for malaria, dyspepsia, dysentery and chronic bronchitis, and after careful experiment pronounced it inert. Linschoten, who studied the cultivation of sweet-flag in Gujarat and the Deccan (A.D. 1598), mentions a preparation called *arata* (a mixture of the rhizome of sweet-flag with garlic, cumin seeds, salt, sugar and butter) which was used as a strengthening medicine for horses. Nicholson (*Man. Coimbatore,* 247) refers to its use in the treatment of foot and mouth disease. [*Cf.* also *Taleef Shereef* (Playfair, transl.), 1833, 34.]

Flavouring.

Trade.

It is generally stated that a considerable demand exists for sweet-flag spirit as a FLAVOURING for gin, beer, etc., and that the supply is obtained from the Broads district in Norfolk. In India it is said to be similarly employed in the manufacture of aromatic vinegar. The rhizomes of the bazárs come mostly from the lower hills of Northern and Eastern India, but the imported Persian root is the most expensive. As an illustration of local TRADE, it may be observed that Mr. Coldstream mentions an export duty charged on sweet-flag in Sarmor State, but the root can be purchased there at the rate of 12 seers per rupee. No particulars are available as to the total Indian trade or the foreign exports, if such exist, but a large supply is obtainable. Sir W. Lawrence (*Valley of Kashmir,* 72) speaks of it as an abundant wild plant in Kashmir, and the same is true of most if not all of the warm temperate tracts. [For Chemical and Medical opinions and results consult Thoms, *Archiv. der Pharm.*, 1886, 465; *Yearbook Pharm.*, 1886, 161; 1888, 131; *Journ. Chem. Indust.*, 1901, xx., 833, 1237; 1902, xxi., 1295; 1903, xxii., 317; *Pharmacog. Ind.*, iii., 539; Kanny Lall Dey, *Indig. Drugs,* 9; H.H. Sir Bragvat Singhji, *Hist. Aryan Med. Sc.*, 52; etc.]

**D.E.P.,
i., 107-8.
Red Sandal-
wood.**

ADENANTHERA PAVONINA, *Linn.; Fl. Br. Ind.*, ii., 287; Gamble, *Man. Ind. Timbs.*, 287; Cooke, *Fl. Pres. Bomb.*, i., 438, LEGUMINOSÆ.

Gum.
Dye.
Timber.
Domestic.

Red-wood (occasionally called Red Sandal-wood or Coral Wood), the *rukta kanchan, rakta kambal, ranjana, mandakaich, thorlagunj, val, bari-gumchi*, etc., etc. Sometimes incorrectly called *rakta-chandan* (*Pterocarpus santalinus*). A large deciduous tree met with in the moist forests of Bengal, Assam, Bombay, Madras and Burma, and readily propagated by seed. A GUM (*madatia*) is said to be afforded by it. The wood is powdered and used as a DYE, and is the red paste (*tilak*) with which the Brahmans colour their foreheads after bathing. Taylor (*Topog. Stat. Dacca*, 1840, 53) says a decoction of both the seeds and wood is used in pulmonary affections, and as an external application in chronic ophthalmia. The TIMBER is much employed for house-building and cabinet-making. The seeds, which are sometimes eaten, are bright red and therefore used for rosaries and as weights (about 4 grains). Ground to a paste with borax they form a useful cement.

D.E.P., i., 108-10.

ADHATODA VASICA, *Nees*; *Fl. Br. Ind.*, iv., 540; ACANTHACEÆ. The *arusa, adulsa, bakas. vasa, basunti, rus, adhatodi, maya*, etc. A sub-herbaceous bush, found throughout the warmer tracts of India up to altitudes of 4,000 feet, and usually very abundant on the Sub-Himalayan tracts but much less common in Western and Southern than in Eastern India. Gregarious and found in large patches, but where it does not grow as a weed it is often semi-cultivated in hedgerows, and under these latter circumstances often attains the proportions of a large bush.

Medicine.

Hooper (*Handbook Imp. Inst.*, 1897, ser. No. 10) incorporates all the information available up to that date and should be consulted. Subsequent investigation has mainly consisted in careful therapeutic tests, with the object of ascertaining the MEDICINAL value of the plant. The results of the inquiries will be found in the *Report of the Indigenous Drugs Committee of India* (i., 38, 68, 183, 385–418, 497). It may be observed here that the verdicts of recent trials in Indian hospitals may be said to confirm belief in the plant as affording relief in chronic bronchitis and asthma, but to preclude acceptance of its reputed virtue in cases of phthisis. The medicinal properties of this plant are mentioned in *The Bower Manuscript*, recently translated by Dr. Hoernle. It is there called *vrisha* (85, etc.).

Dye.
Domestic.

The leaves are sometimes boiled with the sawdust of jack-wood to make a yellow DYE. They seem to be most frequently employed, however, as or with MANURE, being either put on to the fields just before the rains and ploughed in, or scattered over rice-fields recently flooded. It does not seem established whether this agricultural utilisation is as a preventive against noxious insects (see below), or in recognition of the quantity of potash which they contain. At all events it is one of the principal plants employed in India for the preparation of pearl-ash. It appears also to be used not infrequently for gunpowder CHARCOAL, and in Bengal the wood is turned into BEADS. In the Naga hills the stems are used in a kind of augury.

Insecticide.
Manure.

Considerable difference of opinion prevails regarding the use of *Adhatoda* as an insecticide and antiseptic. In *The Journal of the Pharmaceutical Society* (April 7, 1888), Hooper announced that he had discovered the active principle of the plant to be an alkaloid, which he called *vasicine*, but seven years later Prof. Giacosa of Turin (at the instance of Sir Lauder Brunton) threw some doubt on this discovery. by stating that though he had found the leaves rich in potassium nitrate (and therefore a valuable green manure), he had found no alkaloid. In 1897, however, Hooper's discovery was fully confirmed by Dr. W. G. Boorsma of Java, who added interesting suggestions as to the use of *vasicine* both as a drug and as an insecticide. Although the insecticide property would thus seem established, it has been found by practical experiment that *vasicine* cannot be used, as at present available. A tartrate is in the market, but cheaper and equally efficacious insecticides already exist. The use of the leaves, both as a green manure and as a poison to pests, especially on inundated ground (originally pointed out by me in 1887), might with advantage be further investigated and recommended to cultivators in localities where the plant abounds. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 12; Voelcker, *Improv. Ind. Agri.*, 1893, 107.]

D.E.P., i., 117-24.

ÆGLE MARMELOS, *Corr.; Fl. Br. Ind.*, i., 516; Cooke, *Fl. Pres. Bomb.*, i., 192; Duthie, *Fl. Upper Gang. Plain*, 143; Prain, *Beng. Plants*, i., 305; *Rept. Cent. Indig. Drugs Comm.*, i., 137–40; the Bael Fruit; RUTACEÆ.

History.

A small tree found here and there both wild and cultivated throughout India and Burma. It is sacred with the Hindus, the leaves being specially suited for the worship of Siva (Jones, *As. Res.*, 1790, ii., 349–50). It is all but universally known by its Sanskrit name *bilva*, a word which appears in some form, such as *bel* or *bael*, in most modern languages. The fruit is generally called *sriphal*. By the early European writers it was called *Cydonia Bengalensis* or Bengal Quince, and by others was confused with ***Cratæva religiosa*** (which see, p. 429). Garcia de Orta, followed by his reviewer Clusius (*Arom. Hist.*, in *Hist. Exot. Pl.*, 1605, 233) early in the 16th century, called it *Marmelos de Bengala*, and he and other writers make special mention of the value of the fruit in the treatment of dysentery. Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 98) terms the fruit *Malum cydonium*. Rheede (*Hort. Mal.*, 1686, iii., t. 37) calls it *covalam*, but Rumphius, who wrote in 1750, makes no mention of it. Turning now to the Arab authors: Serapion describes three drugs under the names *bel, fel* and *sel*, but does not sufficiently distinguish these one from the other. Avicenna treats *fel* and *bel* as synonymous, and tells us that it is a drug with virtues very similar to the "Apples of Mandragora." [*Cf. Paulus Ægineta* (Adams, transl.), iii., 448.] The *Makhzan-el-Adwiya* describes the fruit as cardiac, tonic and astringent. In ancient Sanskrit poems this tree is frequently alluded to, and by Hindu physicians it is much extolled. [*Cf. The Bower Manuscript* (Hoernle, transl.), 14, etc.; *Pharmacog. Ind.*, i., 277.]

Varieties.

Cultivated and Wild.

Intoxication.

Fish Poison.

There are believed to be several varieties, distinguished by the size and shape of the leaflets when taken in conjunction with the size, shape and texture of the fruit. The main distinction may be said to be into the wild state, with small, hard, round, very astringent and unpalatable fruits having numerous seeds, and the cultivated conditions with large, often oblong fruits, having frequently a comparatively soft rind, a richly flavoured and copious pulp with only few seeds. It has been observed that whilst in Northern, Western and Central India the wild fruits are very intoxicating and are often used as a fish poison, no such character attaches to the cultivated fruit. This curious observation deserves further inquiry. From the Panjáb comes the statement that a form known as *kagzi* has a conically shaped fruit, while the cultivated plant generally met with is known as *bil*, and further that the wild condition (with small round fruits) is distinguished as the *billan*—a name given in other provinces of India to ***Feronia***. [*Cf.* Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 285.]

Cultivation by Seed or Root Cuttings.

Maturity.

The *bael* is usually grown from seed, but in Burma advantage has been taken of the fact that it frequently sends up shoots from the roots, to propagate the approved races by root cuttings. It is generally stated that in from 5 to 8 years the plants will begin to fruit, and that when about 25 to 30 years old, the trees may be regarded as in full bearing. When grown for medicinal purposes only, a small round fruited form, much like the wild plant, is preferred, and it is maintained by the Burmans that the best results are secured when that plant is grown on dry, open, rich soil.

Fruiting Season.

Bael takes ten months to ripen, and it may be said to come into season usually during March and April. In some cases it can be had in December, January and February, but in such instances the fruit has most probably been forced. On the other hand, fresh fruit may be procured as late as June, having been simply left on the trees until required.

Gum.

Properties and Uses.

Cement.

Varnish.

Glue.

A reddish-brown GUM is sparingly obtained from the stem. A gummy or mucous substance is secreted within the cells of the fruit, and thus around the seeds. This is universally used as a CEMENT, and if carefully mixed with lime will be found a clean and useful article that will set rapidly and firmly. It is reported to be obtained more copiously from the wild than the cultivated fruits. In Northern and Central India it is in special demand for the construction of wells, since it sets firmly, takes a fine polish, and is not affected by water. The pure mucus is spoken of as a valuable VARNISH for pictures and as a gum or glue of special merit, where extra security and, at the same time, neatness are desired. It is reported to give brilliancy when added to water-colour paints. In Burma it is commonly mixed with paint as a dryer and to give a glossy surface. But perhaps the most remarkable use of this substance is that recorded in connection with the Madras Presidency. In Madura it would appear that the *yogis* (Hindu devotees) employ the pulp of the fruit as a *kalpam* or substitute for oil. For this purpose a ripe fruit is placed on the hearth until it bursts. The pulp is then removed from the shell, and a little water worked up with it until a glutinous material has been produced. After being purified, the pulp is rubbed over the body. A bath is then taken, when the pulp acts as a detergent and imparts a refreshing and cooling sensation. Of South Arcot it is stated that the mucous fluid only is used for the above purpose, and that it is rubbed on the hair in place of oil by the poorer classes or is employed as SOAP in washing garments. The Dutch in Ceylon used formerly to prepare an ESSENTIAL OIL (*or attar*) from the rind, known as Marmelle Oil (*Journ. Agri.-Hort. Soc. Ind.* (*Proc.*), 1857, ix., 134). A PERFUME is also distilled from the flowers.

Enamel Paint.

Soap Substitute.

Essential Oil.

Perfume.

The MEDICINAL properties of *bael* fruit are so well known that they need hardly be detailed. The fresh ripe fruit is eaten as an article of FOOD by the poorer classes only, more especially the aboriginal hill tribes. By others it is mainly consumed as pickles or preserves or as a refreshing and mildly laxative drink or sherbet. Most writers say that the half-ripe fruit is extensively employed in India as an astringent, digestive and stomachic, and is prescribed in diarrhœa and dysentery, and often proves effectual in chronic cases when all other remedies have failed. For these purposes, however, according to some writers, the wild fruit is preferable to the cultivated. It is certainly much more astringent, contains a larger amount of the gummy substance already mentioned, but has an objectionable quantity of seeds and only a very small amount of pulp. On the other hand, Colonel J. Parker (Medical Storekeeper to Government, Bombay Command) writes (*Rept. Cent. Indig. Drugs Comm., l.c.* 138), "Natives do not use the unripe fruits for medicinal purposes, but the pickle prepared therefrom is considered to be admissible in illness when other forms of pickle are said to be contra-indicated. The half-ripe fruit is adopted by the British Pharmacopœia, but the rind only of the ripe fruit is used at this Depôt in the manufacture of Extractum Belae Liquidum." Moodeen Sheriff recommends for medicinal use a syrup made of the pulp of the ripe fruit, as more especially serviceable for chronic affections, and a powder of the pulp of the half-ripe fruit for acute diseases. He says of the last preparation that it is specially useful in altering the nature of dysenteric motions rather than in reducing their frequency.

Medicine.

Food.

Pickles.

Sherbet.

Liquid Extract.

Syrup.

Powder.

The sun-dried slices of bael (generally known as *belgiri*) may be seen in every drug shop of India. They are not supposed to be injured by time, if kept perfectly dry, but in Europe the same beneficial results have not been attained with this drug as in India, a circumstance explained by European physicians by the theory that the dry slices deteriorate when kept for more than one season. Dymock says, "The best preparation of bael-fruit is a MARMALADE made from the full-grown but still tender fruit, cut in thin slices; it keeps well, which is not the case with the conserve made from the pulp of the ripe fruit that is usually met with in the shops."

Sliced Bael.

Marmalade.

The Root-bark Medicinal.

Dasamula.

Poultices.

Juice.

In addition to the fruit, the root-bark is viewed as medicinal and employed in the treatment of intermittent fevers. The former is one of the chief ingredients in the much-talked-of *dasamula* of Hindu medicine —a preparation from ten roots. The leaves when fresh are made into a POULTICE and used in ophthalmia and maggot-infested wounds. The JUICE expressed from the leaves is bitter and pungent. Diluted with water it is highly spoken of as a remedy in catarrh, fever and biliousness. It may be preserved by being boiled in oil. The leaves are eaten in order to destroy the desire for food, and are so employed by *sadhus*. Bael fruit is employed in the treatment of scum in vinegar manufacture (see p. 1110).

Timber.

The TIMBER, yellowish-white, mottled, close-grained, hard, has no heartwood, is not very durable and is readily attacked by insects. It weighs from 40 to 50 lb. per cubic foot. When freshly cut it has an aromatic smell. According to certain Hindus it is sacrilege to cut this tree down, but chiefly when cultivated and more especially when near temples. In the wild state, or when the tree has been neglected or has been killed, it may be felled and the timber utilised even for fuel or charcoal. It is used in the construction of sugar and oil mills, carts, agricultural implements, and, according to some writers, in the construction of idols, combs, and beads for certain rosaries. In the *Institutes of Manu* (ii., 45) the wood is given as an alternative with that of ***Butea frondosa***, whence the Brahman sticks may be made.

Trade.

Although there must be a very large local TRADE in *bael*, nothing in the way of actual returns can be quoted. The dry fruits sell at about Rs. 1 per 100 and the green fruits at less than half that figure. The dry pulp (*belgiri*) can be purchased at about Rs. 20 per cwt. Although several firms, such as the Great Eastern Hotel Company, Ltd., in Calcutta, regularly manufacture the marmalade, the article does not appear to be exported to any appreciable extent. In the London "price-current," quotations are given of dried and sliced fruit fetching from 1*d.* to 4*d.* per lb. It is often observed, however, that the market is neglected and the demand very limited.

Snuff-boxes.

Fireworks.

Beads.

The dried fruits, with pulp excavated, are largely employed as boxes in which to store medicines, sacred ashes, etc. Small ones are beautifully carved, and made into SNUFF-BOXES. A considerable trade is done all over India in these ornate boxes, but it is feared that the majority may in reality be made from the small hard fruits of ***Feronia***, rather than of ***Ægle***. In the snuff-boxes made at Peshawar there is a considerable export to Kabul and Lower India. Ganjam, far to the south, is famed for its charmingly carved snuff-boxes—these show the 10 incarnations of Vishnu. Charged with gunpowder, the small dry fruits are also employed as bombs in FIREWORK exhibitions. Very young fruits (about half an inch in diameter) are used as BEADS and are arranged alternately in necklaces with the seeds of ***Elæocarpus Ganitrus*** (the *rudrak*). These are specially worn by religious men of the Siva sect. The wood ground down on a stone to a paste, with a little water, is often employed alone or in combination with sandal-wood to give the white transverse caste markings on the forehead of the Sivites.

[The following works may be consulted, in addition to those indicated above or mentioned in the *Dictionary*:—Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 153; *Journ. As. Soc.*, 1819, vii., 264; Ainslie, *Mat. Ind.*, 1826, ii., 188; *Taleef Shereef* (Playfair, transl.), 1833, 42, 54; *Journ. Agri.-Hort. Soc. Ind.* (*Proc.*), 1857, 133; 1859, x., 157; 1863, xii., 348; 1865, xiii., pt. ii., 61; 1869 (n.s.), i., pt. ii., 58; 1872, iii., pt. ii., 14–26; Basu, *Agri. Lohardaga*, 1890, i., 130; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 84–7; *Bull. Dept. Agri.*, 1896, Nos. 2, 8; Innes, *Jungle Prod.*, 1898, 8; Banerjei, *Agri. Cuttack*, 1893, 191; Woodrow, *Gard. in Ind.*, 1899, 217; etc., etc.]

**D.E.P.,
i., 125-6.
Sola Pith.**

ÆSCHYNOMENE ASPERA, ***Linn.:*** Roxb., *Trans. Soc. Arts*, 1806, xxiv., 156; *Fl. Br. Ind.*, ii., 152; Gamble, *Man. Ind. Timbs.*, 1902, 237; Prain, *Beng. Plants*, i., 418; Duthie, *Fl. Upper Gang. Plain*, 1903, 271; LEGUMINOSÆ. The *shola* (Hind.), *sola* (Beng.)—a word corrupted into *solar* by English writers and manufacturers; is also *atunete, benda, pani* (water)-*kuhila, kagdia, kagdia-dhendor*, etc. The present species is often designated in Bengal and Assam, *bhat* (white or rice-like)-*sola* or *phul* (flower or soft)-*sola*, in order to distinguish it from—

Æ. indica, *Linn.*; the *kat* or *kath* (hard)-*sola*, *kuhila*, *kathia-dhendor*, etc. The *chirmilli* or *sirmilli* is *Sesbania* and not *Æschynomene*—a plant often used as a substitute for *sola*.

Habitat. Distribution. Seasons.

The former species is a floating bush, with sensitive leaves, found on land annually inundated or within the margins of tanks or lakes throughout Bengal and the greater part of Assam; is frequent in Burma and also present in South India. The latter, a taller more bushy plant and much less aquatic in habit, represents the genus in the other provinces, is found in Bengal, Assam and Burma only above water-level, or on land temporarily flooded. Neither species is systematically cultivated, but in November and December the upper portions of *Æ. aspera* bearing pods are severed and thrown on the water and the seeds thus become self-sown. The roots also are perennial. By February-March the pods are ripe and the pith-yielding shoots over-ripe; the stem then becomes dry, shrunk and discoloured, whilst a large cavern forms along the centre. The plant usually grows in from 2 to 4 or 6 feet of water, and when found living above water-level it appears to be unhealthy. It is often seen in the corners of rice-fields, but as a rule is viewed as a pernicious weed, and accordingly uprooted.

Cork Substitutes. Manufacturers. Preparation. Stripping. Hats, etc.

Roxburgh would appear to have been the first person to draw attention to this plant and its economic uses. He recommended its adoption as a substitute for cork in the manufacture of swimming-jackets and lifeboats. But it is curious that he makes no mention of its use in the construction of hats (*sola-topis*). In Bengal and Assam the workers in Pith usually belong to the Malakar or Mali caste of Hindus, who as a rule acquire the hereditary and exclusive privilege of manufacturing garlands for ceremonial use in certain districts. The thicker portions of the stems only are cut into lengths of 2–3 feet. These are tied into bundles and stored until dry, when the brown bark is removed and the pith cut up as required. If intended for the manufacture of hats, caps, or frames of puggries, it is split into thin sheets. For this purpose the stem is held in front of the operator and with a long thin, sharp knife is stripped spirally, the knife being made to travel round and round within the thickness until the whole stem is reduced to a sheet not much thicker than note-paper. Hats, etc., are worked up on wooden or clay moulds, and, if honestly made, are built up layer upon layer of *sola* sheets pasted one on the top of the other. By dishonest makers a large proportion of paper is intermixed with the pith, thus adding greatly to the weight of the hat and lessening very materially its insulating power (to the rays of the sun) wherein lies the superiority of the pith hats (*sola-topis*) over all others used in the East.

Flower Manufacture. Swell when moistened. Stamens or Buds.

In the Roorki district the pith from *Æ. indica* is very largely used for *sola-topis* with a surface-dressing of Bengal pith. Owing to its hardness, this form of pith cannot be split into the very thin sheets needed for flower manufacture. If pith be required for this purpose, or for weaving into mats, the debarked stalks of *Æ. aspera* are drawn between bamboos fastened upright in the ground at various distances apart, or are flattened by means of smooth stones. By either of these methods the pith is compressed, and will retain the form thus given it until moistened, when it again expands. To make a flower, the strips of *sola* are compressed in such a manner that in transverse section they are more or less triangular in shape, and along the surface, corresponding to the base of the triangle, parallel lines are cut. The strips are then sliced transversely with a sharp knife into very thin pieces. The pointed ends of the triangles are inserted into slits made on another stick of *sola*, intended as the stalk of the flower. When the required parts have been thus inserted into their places a brush, moistened in green-coloured water, is made to touch the outer whorl of triangles. These instantly expand and become the sepals of the rose or other flower. A brush, moistened in pink or other coloured water, next touches the inner whorls, and these, obeying the magician's wand, expand into petals, and are bent while still flaccid into the desired positions. The slits cut lengthwise along the compressed sticks of *sola* are now seen to open out into petaloid teeth. Stamens are formed of thin strips of pith, upon the extremities of which, particles of sugar (from a coloured saccharine fluid) have been made to crystallise, thus forming glistening anthers. Floral buds are constructed of stained grains of rice fastened within green leaflets of *sola.* [*Cf. Ind. Art at Delhi,* 1903, 169.]

Local Manufacture.

The three great centres of this art may be said to be Dacca and Mandalay for small and large flowers respectively, and Tanjore for models; but the ceremonial craft of the Malakars is practised all over India. The introduction of matches has practically rendered obsolete the domestic use of *sola* as a tinder with flint, but the pith is now made into covers for water-bottles, stoppers for medicine-bottles, and plugs to widen ear-ring holes in the ears. It is also employed as a lining for the tops of palanquins and for seats and cushions, as also for the ornate Muhammadan *tazias* used at the Muharram. The cheaper pith of ***Æ. indica*** is usually employed for fishing-floats, fishing-baskets, rafts and swimming-belts, as it is supposed to be specially durable in water. Where procurable in abundance it is said to be especially useful in firing pottery, and the charcoal made from it is highly prized in the manufacture of gunpowder.

Medicine. Chemistry. Food and Oil.

The soft *sola* (***Æ. aspera***) is used in surgery for insertion into the opening of a sinus or abscess since it rapidly absorbs moisture, expands, and thus widens the opening. A long article on the *Chemistry of Sola* by Hanncock and Dahl will be found in *The Chemical News* (July 12, 1895). The leaves of the *sola* plant are sometimes used as a POT-HERB, and an OIL is extracted from the seeds. [*Cf.* also Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 253–5.]

Trade.

There is practically only a local demand for *sola*-pith, and in its unmanufactured condition it is hardly ever exported. The best quality is obtainable in Bengal, and is carried thence all over India. To this day the centre of the TRADE may be said to be in Calcutta, where the manufacture of *sola-topis* appears to have originated. No information is available as to the trade in the harder pith of ***Æ. indica,*** but it may be recognised by the circumstance that the stem is curiously striated on the thin bark and has wart-like formations along the striations. A central pith is always present in the form of a hollow surrounded by a slightly hardened layer. In ***Æ. aspera*** the bark is not striated; the stem unless over-ripe is quite solid, very soft and of a pure white colour. [*Cf.* Acosta, *Tract. de las Drogas,* 1578, 241; *Journ. Soc. Chem. Indust.,* 1903, xxii., 198; *Der Tropenpflanzer,* v., 598.]

Substitutes.

Sola Substitutes.—The following are the chief substitutes:—

Aralia armata.
Cassia mimosoides.
Cephalanthus occidentalis.
Heptapleurum hypoleucum.
Mimosa pudica.
Pentapetes phœnicea.
Sesbania paludosa.
Sonneratia acida.
Trevesia palmata.

D.E.P., iii., 18.

AGATHIS LORANTHIFOLIA, *Salisb.;* Gamble, *Man. Ind. Timbs.,* 703; CONIFERÆ. A lofty tree met with in Burma and the Malay Peninsula and islands.

Dammar. Varnish.

It is in Burma known as *theet-men* and is generally spoken of as the Amboyna or White Pine. It affords a large quantity of transparent resin known as DAMMAR, which is used like that of the New Zealand *cowdie* or *kauri dammar* (***Agathis australis,*** *Salisb.*) in the manufacture of VARNISH similar to Copal and for waxing and polishing fabrics. [*Cf.* Roxb., *Trans. Soc. Arts,* 1805, xxiii., 412–3.]

D.E.P., i., 133 44.
Aloe and Sisal Fibre.

AGAVE, *Linn., Gen. Pl. n.,* 431 (ed. vi.), 1767, 171; Thurston, *Extract. of Fibre,* in *Bull. Dept. Land Rec. and Agri. Mad.,* 1903, No. 30; Drummond and Prain, *Notes on Agave and Furcræa,* in *Bull. Dept. Land Rec. and Agri. Beng.,* 1905, No. 8; reprinted in *Agri. Ledg.,* 1906, No. 7; *Fl. Br. Ind.,* vi., 277; AMARYLLIDEÆ.

ALOE AND SISAL FIBRE

Drummond and Prain, the most recent authors on the Indian Agaves, review the various botanical opinions that have been advanced, give a complete history of the useful species, and also furnish a record of publications so exhaustive as to render further treatment in this work almost undesirable. The citation of publications below is intended therefore to amplify the enumeration given by these authors in so far as works, mainly of practical and commercial interest, are concerned.

Habitat.

Distribution.—The species of *Agave* are indigenous to tropical South America, Mexico and the Southern States of North America By cultivation (chiefly during the 16th to 18th centuries) the forms of industrial and horticultural interest have been distributed throughout the greater part of the warm temperate and tropical regions of the globe. Several have even become acclimatised (or have run wild) in South Europe, Africa, India, the West Indies and some portions of the American Continent where they are believed not to have been indigenous. While completely naturalised in the warmer tracts of India, one of the species has become equally at home on the hills up to an altitude of 6,000 feet, provided the soil be dry and rocky, and the atmosphere not too moist. They are best known under the following names—American Aloe, Century Plant, Carata, Pita, Sisal Hemp, White Rope Fibre, and the like.

Earliest Account.

Indian Record.

Not mentioned by Early Writers.

History.—One of the earliest detailed accounts of the economic properties of these plants was that given by Gomara (*Hist. Gen. de las Indias,* 1554, 334). Writing of the Spanish West Indies including Mexico, he speaks of a plant known to the Natives as *metl* or *maguey* (= tree of wonders) and to the Spaniards as *cardon* (the thistle). He gives a statement of its use for textile purposes, and explains the name *fil-y-agulla* as referring to the use of the spine as a needle and the fibre as thread. Fragosus (*Hist. Med. Ind.*, 1600, 88) mentions the wine obtained from the plant (*paclire*—the *pulque* of later writers). Dodonæus (*Purgantium,* 1574, 115) publishes a plate borrowed from Clusius who had it prepared from a plant seen by him near Valentia (*Rar. Stirp. Hist. Hisp. Obs.*, 1576, 442). The same plate did duty in some form with later writers for the next two hundred years, though it usually appeared side by side with the plate of Camerarius (*Hort. Med.*, 1588, 10–11, t. v.). In 1727 Trew published an excellent monograph on the subject with a careful drawing of the flower. As regards India the first authentic reference would appear to be that of Roxburgh (*Obs. on Substitutes for Hemp and Flax,* 1801). In *The Journal of the Society of Arts* (1804, xxii.) he speaks of Agave as wild and beautiful, and in his *Hortus Bengalensis* (1814, 25) he mentions three species, ***A. Cantala, A. lurida,*** and ***A. tuberosa.*** The *first* he tells us had been introduced into the Royal Botanic Gardens, Calcutta, before 1794 (from India, locality not stated), and further he affirms that it possessed a Sanskrit name—*kantala*; the *second* he speaks of as a native of America; and the *third* he says had been procured from Kew but turned out to be the plant called "Yucca Superba" of the Calcutta Gardens—a plant which had been procured direct from America in 1799. Subsequently Roxburgh (*Fl. Ind.*, ii., 167) was induced to think it wild. But neither the name *kantala* (nor any other) has been accepted by other writers as being Sanskrit. Roxburgh doubtless obtained it from Sir W. Jones (*As. Res.*, iv., 230). It is possibly a gloss on *katevala,* Rheede's name for the medicinal aloe. The names that exist are mostly descriptive or comparative and thus modern, for example, *banskeora* (= the bamboo ***Pandanus***) or *bara kanvar* (= the large aloe). From Vasco da Gama (1498) down to Hedges (1683) none of the Indian travellers seem to mention agave. It is not referred to in the *Memoirs of Baber* nor the *Administration of Akbar* (the *Ain-i-Akbari*), though the pine-apple appears in the latter work. It is perhaps referred to by Hove in 1787, and twenty years later Buchanan-Hamilton speaks of its being much planted as a hedge. There is reason to believe that it was introduced into Northern India by Rohillas from the south on purpose to be employed as an impenetrable hedge around forts. The name *ketki* (usually restricted to ***Pandanus***) is the most general name for agave in Central India. But it is significant that Rheede should say nothing of agave in his account of the plants of the West Coast of India (1678), while Rumphius (*Herb. Amb.*, 1750, v., 273, pl. 94) should describe and figure a plant which is certainly agave and possibly ***A. Cantala***. It seems then to have been a very recent discovery, and it probably reached India from America by the trade-route, *viâ* the East Indian Archipelago.

Action of the Director of Kew.

Three Government Consignments.

Acclimatisation in India.

Official Action.

Private Consignments.

Brief History of the Efforts to acclimatise Sisal Fibre in India.—The several Governments of the West Indies (more especially of the Bahamas) have made strenuous efforts to participate in the sisal hemp trade, and the Blue Books that have appeared from time to time contain much of great value. It is perhaps safe to say of India that by far the most important contribution to the existing knowledge of cultivated agaves has been the direct outcome of the great personal interest taken by the former Director of the Royal Gardens, Kew, Sir William Thiselton-Dyer. Live plants of all the more highly approved species and races of agave were procured and the more interesting of these distributed to the Colonies and India. Reports have at the same time been obtained from the indigenous habitats of the various species as also from the regions of most successful production, and these have from time to time been published in the *Kew Bulletin*. Still later the information thus collected has most considerately been brought together and republished in one volume (*Bull.*, add. ser., 1898), thus forming a convenient book of reference that gives full particulars of the results attained within recent times. The Director of Kew, at the suggestion of Sir George King, and subsequently of the Revenue and Agricultural Department of the Government of India, procured and forwarded to India three consignments of live plants of sisal hemp. The *first* reached India on July 9, 1890, but the plants were found to be dead on arrival at the Royal Botanic Gardens, Sibpur, Calcutta. The *second* consignment of 1,000 plants came to hand on October 29, 1891, and it was then found that 643 were alive. The *third* consignment of 4,900 plants reached Sibpur on October 14, 1892, and of these 2,984 were alive. Prior to these consignments, however, the Botanic Gardens, Saharanpur, had received by post in 1886, direct from Florida, a few live suckers. One of these had been successfully grown and had yielded many young plants, of which a limited distribution was made. Recently a report was called for as to the success attained with the 1892 consignment of plants. The preparation of that report was entrusted to Lt.-Col. D. Prain, at that time Curator of the Calcutta Herbarium. The recipients of the plants issued from the Royal Botanic Gardens were invited to furnish information on eleven separate subjects of inquiry, such as the nature of soil on which the plants had been grown; distance planted apart; percentage of deaths; the date on which they afforded suckers; date at which the plants were cut; the length of fibre obtained; the method adopted in preparation of fibre, etc., etc. It may be here explained that the Agri.-Horticultural Society of India having received a supply of plants from the Superintendent of the Royal Botanic Gardens, Calcutta, issued these to the members of that Society, and the answers furnished to the series of questions were published in the *Journal* (1898, xi., n.s., 864–8). The replies received by Prain were incorporated in his report. This was republished in *The Agricultural Ledger* (1900, No. 6), and may therefore be regarded as a most important practical contribution to our knowledge of the sisal hemp fibre in India. It will be there found that Prain concludes a letter to the Hon. Secretary of the Agri.-Horticultural Society of Madras as follows: "I may add, for your information, that since preparing my Note I have learned that two private importations from Florida of Sisal Hemp plants, one in the Tirhut (indigo) area, and one in Assam (tea) area, have taken place, the parties concerned having said nothing about these importations, and all that I am able to say regarding them is that the efforts of the various Indian Governments, detailed in my note on Sisal *plus* those of your Society and of the Government of Madras are, when put together, insignificant as compared with either of those private ventures." Of Dauracherre, in South Sylhet (the Assam instance doubtless in the above

South India in 1900 stated that the Mysore Government had imported over 4,000 plants direct from Florida about seven years previous. These had taken kindly to the climate and now afforded material for an extensive propagation.

Recent Publications.

Carrying the Indian records to more recent dates, two exceedingly important papers have appeared: (1) *A Note on Agave and Furcræa* by Drummond and Prain, and (2) *Sisal Hemp Culture* by Mann and Hunter. The former tackles in an able manner the much disputed botanical origin of the commercial plants and the latter gives useful details of an Indian plantation. Before dealing with the practical issues it may be advantageous to exhibit in this place the botanical opinions.

Species.

Sources of Ambiguity.

Species and Varieties.—The necessity for a complete revision of the species of this genus, more especially the cultivated forms, has long been felt as very urgent. Much has been done by systematic botanists for the wild forms in their native habitats, but much still requires to be accomplished before we possess the accurate knowledge essential to industrial progress. Cultivators have not always gone to botanists to secure their original supplies. There have in consequence been carried here and there throughout the tropics a multiplicity of forms, some at least of which in their new homes seem to have made confusion confounded by modifying the colour, shape and spinosity of their leaves until they have greatly obscured their botanical characteristics. And these have also brought with them incorrect or even quasi-scientific names that have passed unchallenged for many years. Hence it is no matter for surprise that the *Agave lurida* of one high authority is not the *Agave lurida* of "certain practical men." The blame for this state of affairs cannot, however, be cast at the one or the other: errors and misconceptions are unavoidable in the early stages of most discoveries. The necessity for a common basis of knowledge is now, however, the more urgently demanded. Drummond and Prain (*l.c. Agri. Ledg.*, 1906, No. 7) have taken a most valuable step in the direction of the elimination of ambiguity. They have reduced the Indian cultivated and acclimatised forms to some ten species, and of these five or six are of industrial merit. It would be presumptuous for any one who has not specially studied this perplexing genus to venture on a critical review of the conclusions arrived at by these distinguished botanists. I shall accordingly content myself with an effort to transcribe into one place what appears to me of special value to practical men, and in so doing endeavour to focus my abstract alphabetically under the scientific names given in the *Notes* for the chief forms:—

Industrial Forms.

The Horticultural Agave.

Agave americana, *Linn., Sp. Pl.*, 1753, i., 323.—This plant (to which alone that trivial name should be restricted) exists in India as an ornamental garden plant only. It is extremely constant in its characteristics, and except as horticultural sports (in which the leaves become parti-coloured) it has no authentic varieties. Although a fibre can be and has been extracted from its leaves, this plant is of no value as a textile and does not exist anywhere in India in such abundance as to be of importance. The cultivated stock probably originated in the West Indies. [*Cf.* Drummond and Prain, *l.c.* 84–5, 121–2, 126, 136, 151.]

A. Cantala, *Roxb.; A. vivipara, Dalz. & Gibs.* (*non Linn.*), *Fl. Bomb.* (suppl.), 1861, 93.—This would appear (as indicated above) to have been the species that first reached India. It had taken such a firm hold of the country by 1804 that Roxburgh, when led to suppose that it had a Sanskrit name, was induced to regard the plant as indigenous. It is common in hedges and one of the two species most widely spread and most plentiful in India. Frequent near Bombay, in the northern portions of Madras Presidency, in Central India, and in the Gangetic plain generally, as far north as the sub-mountain districts of the provinces of Agra and the Panjáb, ascending the hills to close on 6,000 feet, but is absent from the arid strip between Gwalior and Delhi. Fibre is extracted from its leaves in considerable quantity, but opinions on its quality are conflicting. It is the chief source of the Bombay Aloe Fibre of commerce. [*Cf.* Drummond and Prain, *l.c.* 87-8, 100, 105, 133-4, 135, 138-9, etc.]

Bombay Aloe Fibre.

A. *sp.* (**? A. elongata,** *Jacob.*).—Drummond and Prain (*l.c.* 88, 101, 105, etc.) show that the plant here indicated cannot be identified as *A. mexicana, Lamk.* Further they observe that it approaches *A. sisalana* and is intermediate between that and *A. Cantala*. It seems very close to the species cultivated at Kew as *A. rigida, var. elongata*. It has been met with in the Upper Gangetic plain, as for instance at Dehra Dun and the Panjáb Siwaliks; it is somewhat extensively planted along railways in N.W. India, and is the most prevalent form in the dry arid tract from Gwalior to Delhi, being there, as it were, obtruded into the area of *A. Cantala*. The fibre has not been sufficiently investigated, but it seems good and would probably be found valuable. The plant has been grown on a marketable scale in the dry tract between the Chambal and the Jumna.

The Agave of the Upper Gangetic Basin.

THE SPECIES OF AGAVE

Cultivated Sisal.

A. sisalana, *Perrine.*—The True Sisal Hemp Plant of India, Australia, the Pacific Islands, etc. This was introduced on various occasions between 1885 and 1892. It is cultivated in Burma, Cachar, Sylhet, Assam, Bengal, N.W. India (as far as Lahore), Central India, Bombay, the Deccan (Poona), Mysore and Madras (Bellary). Original stock, obtained from cultivation in Yucatan, conveyed in 1834 to Florida and other parts of America, thence to the West Indies and finally to India. There are forms with the leaves having the margins spinose and others naked, but these conditions may be found on the same plant, so that they are not varietal in value. The seedlings and bulbils of both forms are spinose. There is but one form of sisal in all India. Mr. Cameron fixes its introduction into Mysore in the year 1892. He mentions that the Lal Bagh of Bangalore had recently sold from its stock 45,000 plants. [*Cf.* Drummond and Prain, *l.c.* 83, 89–90, 96, 99, 103, 117, 135, 143–7; also *Proc. Agri.-Hort. Soc. Mad.*, 1903, 44–6.]

The Agave of the Lower Gangetic Basin.

Inferior Aloe Fibre.

A. Vera Cruz, *Miller, Dict. Gard.* (ed. 8), 1768, No. 7.—Possibly this plant came originally from Mexico. It is naturalised throughout Southern Europe, in most of the Mediterranean Islands and in N.W. Africa, but has not been recorded from S.E. Europe or the Orient, etc. This would seem to be the ***A. americana*** of Clusius, and of most writers prior to the time when Linnæus restricted that name to the special ornamental garden plant. It has been called ***A. lurida*** by some writers (but is not ***A. lurida,*** *Jacquin*). Introduced into India from the Chelsea Physic Garden by Lord Auckland during 1836, and looked on by Wallich as doubtfully distinct from ***A. "lurida."*** Recorded as met with here and there practically all over India, but more especially in the Eastern Peninsula. Is spoken of as frequent in the Gangetic plains north to Cawnpore, used for hedging and luxuriates in Calcutta gardens, but rapidly disappears from all localities subject to occasional frosts, It stands a moist atmosphere more successfully than do most other species. and has become naturalised in Mysore. The fibre has not been separately reported on, so that its special properties, if any, are not at present known. [*Cf.* Drummond and Prain, *l.c.* 80, 83, 86–7, 99, 106, 121, 126, 131, 140, etc.] The above may be given as a conspectus of the opinions held regarding this species. Compiling from an extensive correspondence and comprehensive series of practical (not botanical) opinions, it would appear highly probable that the fibre of this plant has given origin to the low valuations of the so-called Aloe Fibre of India.

The Agave of Drier Tracts.

A. Wightii, *Prain; A. vivipara, Wight, Ic. Pl. Ind. Or.*, vi., n. 2024; Baker, *Gard. Chron.*, n.s. 1877, viii., 780 (*non Linn.*). The Bastardi Aloe.—This is a well-known naturalised form in Southern, Central, Northern and Western India. It is wrongly regarded by some as being ***A. Cantala,*** *Roxb*, and is often spoken of as *desi* or "Native" owing to its being self-sown. It is easily recognised by its round, compact rosette of pale-coloured rather stiff leaves. It is widely spread in the drier tracts of India from Mysore to the Panjáb. It extends to the extreme south and to the east of Bengal and Assam, but does not thrive in damp countries. The fibre has been reported as good but shorter than ***A. sisalana***, and on that account is not so much in demand as formerly. [*Cf.* Drummond and Prain, *l.c.* 91, 101–3, 123, 139, etc.; Greengrass, Letter in *Madras Mail*, 1903.]

Yields a Good Fibre.

A. ? longisepala, *Tod.*—This is species (H.) of Drummond and Prain (*l.c.* 90). It is naturalised at Saharanpur, met with near Calcutta, and also in Southern India and N.E. Burma, though nowhere on a large scale. It is distinguished in Saharanpur as *rambans keora*, and is understood to be most probably the plant that furnished the fibre favourably reported on so many years ago. It has an acrid juice.

[*Cf.* Martius, *Fl. Brazil*, 1842–71, iii., pt. i., 183–6; Terracciano, *Monog. delle Agave*, 1885; *Kew Bull.* (numerous articles), 1887–92; Dodge, *Rept. Sisal Hemp Cult.*, U.S. Dept. Agri., 1891, No. 3; also *Leaf Fibre of U.S.*, 1893; Morris, *Comm. Fibres, Cantor Lect. in Journ. Soc. Arts*, 1895; Pinart et Bourgeois, *L'Aloe Amer.*. 1896; Dodge, *Useful Fibre Pl. of World*, 1897, 41–53; *Text. Journ. Ind.*, April 1899; *Pioneer*, Sept. 1899; Rogers, *Ind. Gard.*, Nov. 1900; *Ind. Agri.*, Feb. 1901; *Colon. Repts.* (*Bahamas*), 1900, No. 327; Jumelle, *Les Cult. Colon.* (*Indust.*), 1901, 61–6; *Capital*, June 1902; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 375–89; Dunstan, *Imp. Inst., Tech. Repts.*, 1903, 58–9; Dewey, *Prin. Comm. Pl. Fibres*, in *U.S. Yearbook*, 1903, 395; *Philippine Bureau Agri.*, 1904, No. 10.]

Synopsis of the Properties and Uses.

The Fibre.—The leaves yield a fibre, the ALOE FIBRE, SISAL HEMP or VEGETABLE SILK, which in common with most fibres of this class is often designated *Pita.*

Medicine.

Medicine.—The large, moist, fleshy leaves are sometimes used as a poultice. The expressed juice of the leaves is administered by American doctors as a resolvent and alterative, especially in syphilis (Ponder and Hooper, *Mat. Med. Ind.*, 165). The roots are diuretic and anti-syphilitic, and are said to find their way to Europe mixed with Sarsaparilla. Prescott (*Hist. Mexico*) says that when properly cooked, the root affords a "palatable and nutritious food."

Food and Fodder.

Food and Fodder.—In its young green state the stem is regularly used as an article of FOOD, as for example during the famine of North Arcot (Lisboa, *Useful Pl. Bomb.*, 205). In *The Agricultural Ledger* (1893, No. 3) Mr. J. O. Miller gives the results of the experiments made in the United Provinces to test the value of these plants as articles of food, and the conclusion may be said to have been unfavourable. The leaves are occasionally utilised as FODDER, especially for ostriches. [*Cf. Agri. Journ., Dept. Agri. Cape Colony*, July 1896, 252, 386.]

The Sap.

Beer and Brandy. Mescal.

The Sap.—If the central bud be lopped off at the flowering season, the cut stem discharges freely a sour-sweet liquid which ferments rapidly and forms the Pulque beer of the Spaniards, or by distillation a kind of brandy known as *Mescal.* The putrid odour of the *pulque* is said to be due to the vats in which it is fermented being made of hides (*Century Dict.*, 1899, vi., 484). The species specially cultivated for *pulque* is probably *A. Salmiana, Otto*, never *A. americana, Linn.* [*Cf. Journ. d'Agri. Trop.*, 1901, 42; Drummond and Prain, *l.c.* 98; *Bull. Un. Agri. Caled.*, 1903, ix., 11.] Sugar and vinegar may also be prepared from the sap.

Sugar and vinegar.

Soap Substitute.

Cement.

White Ants.

Industrial.—The juice may be used as a SUBSTITUTE for SOAP. Wall-plaster impregnated with the expressed juice is said to be proof against the ravages of white ants. (This same statement of the use in Cement has, it will be found, been made under **Aloe**, p. 59) A writer in *The Madras Mail* (Oct. 1901) says that the juice rubbed on the hands and feet protects them from injury by fire, hence the "fire-walking" of the Saniyasis. The flowering stem, dried and cut into slices, may be employed as a natural razor-strop or as a substitute for cork. The pulp after removal of the fibre is a valuable manure for the land on which the plant has been cultivated. It is rich in lime, magnesia and potash.

Razor-strops.

The Fibre.

Fibre.—If possible, it would seem the most useful course to refer the observations that follow to two sections: (I.) THE PRODUCTION OF THE ALOE FIBRES and (II.) THE PRODUCTION OF SISAL HEMP. The former practically means the fibre from stock acclimatised in India many years ago, and the latter the fibre of more recently introduced plants. There are, however, only two or three localities in India where Agaves are systematically cultivated, and in these plantations, both old and new stock doubtless exist. But so much ambiguity and disappointment have resulted from not separately recognising the merits of the old stock that it seems desirable to endeavour to separate the Indian fibre into the two groups indicated, viz. American Aloe Fibre (old stock) and Sisal Hemp (new stock), (pp. 39–43).

I. ALOE FIBRES.

From the remarks made under the paragraph above on the botany of these plants it may be learned that the Indian fibres of this kind are derived from ***A. Cantala, A. Vera Cruz, A. ? elongata and A. ? longisepala.*** The assumption that the varying qualities of the Indian fibre were exclusively due to diversity in climate, season, age of collection, and methods of separation, etc., has been completely upset by Drummond and Prain's recent paper (already briefly reviewed). We now know that there are several distinct species and that the ***A. americana*** proper is the most inferior and least important of all.

The necessity for a full knowledge of the plant being or proposed to be cultivated in any locality cannot be disputed. Prain (*Ann. Rept. Roy. Bot. Gard., Calc.*, 1903-4) says :—" The Sisal Agave does not thrive equally well or give equally remunerative results in all parts of India, and in certain districts species of Agave other than *sisalana*, already so completely naturalised as to appear indigenous, thrive so much better than Sisal and yield fibres commercially so little inferior to the best Sisal fibre that their systematic cultivation offers a hopeful field for investment." " It seems that, while, as a rule, more or less well-defined areas have particular species well established, the prevailing species in one area often differs from that most plentiful in another area. Moreover, it is found, when attempts are made to utilise the fibre of these local Agaves, that somewhat diverse results are obtained : at times the fibre extracted is reported to be nearly up to the standard of Sisal, at other times it proves too weak to be worth extracting. The explanation of these facts appears to be that other species of Agave share with ***A. sisalana*** the peculiarity of adapting themselves readily to certain localities and thriving less vigorously in others. The original object of the introduction of all the species was to provide secondary lines of defence round stockades, forts and strong villages ; in more settled times they have been chiefly used as hedges bordering highways and lines of railway. Vigour of growth therefore has been the only quality considered in selecting plants within any particular area ; the nature of the fibre has not till recently attracted attention." In selecting stock there would seem to be every likelihood that it may be possible to discover two plants with equally (or nearly equally) good fibres, the one of which would poll in seven to twelve years, the other not till much later, say twenty-five years. There would be an obvious advantage in the latter, namely the greater number of years before the estate would have to be completely renewed.

Polling Season

Report on Indian Samples.

Technical Reports on Indian Samples of Fibre.—Two samples of Indian so-called American Aloe Fibre (or what were believed at the time to have been such) were in 1893 examined and reported on by the Director of the Imperial Institute, London. These had been procured in 1891 by the Government of India from Saharanpur in the United Provinces, and by Thurston (Off. Reporter on Economic Products) from Coimbatore in the Madras Presidency. [*Cf. Agri. Bull., Mad.*, 1894, No. 30.] Mr. Collyer of Messrs. Ide & Christie (the expert consulted) reported very favourably on both samples, and in consequence a series of questions were asked by the home authorities which were circulated to persons known to be interested in Agave fibre. The late Mr. Gollan, among others, replied to the questions and thereby afforded more direct and personal

Possible Errors.

Source of Saharanpur Fibre.

knowledge regarding the Saharanpur sample and the cultivation of the plant, than will be found in the other Indian reports which have as yet appeared. [*Cf. Agri. Ledg.*, 1894, No. 18.] Some doubt, however, may be admitted to overshadow most of the published statements regarding the so-called *Agave americana* of India from the exact species experimented with not having been accurately determined. But Mr. Gollan, who actually supplied the Saharanpur sample (along with his letter of February 3, 1891), wrote in reply to a special reference on this point, that at the time in question he furnished two consignments, one of the so-called *A. americana* (much of which very possibly should now be called *A. ? longisepala*), the other of *A. vivipara* (or rather *A. Wightii*) fibre, but none of *A. sisalana*, for the very good reason that no plants of the last-named species had reached Saharanpur until fully a year later, and no fibre from the Sisal plants had been cut until four years later. [*Cf. Agri. Ledg.*, 1900, No. 6, 63.] The point is of importance chiefly in support of the contention that certain forms of Indian-grown Aloe fibre are little if at all inferior to the true Sisal of Commerce. The fibre that Mr. Collyer viewed with so much favour was thus procured from two of the long-acclimatised plants prevalent in North India. Subsequently Mr. Gollan furnished samples of Sisal fibre grown at Saharanpur, and these were also sent to the Imperial Institute for opinion and valuation. [*Cf. Agri. Ledg.*, 1896, No. 34; *Imp. Inst. Tech. Repts.*, 1903, 81–5.]

A sample of Agave fibre from Gwalior (possibly the plant indicated above as *A. ? elongata*) has been highly commended (*Imp. Inst., l.c.* 84), and a sample from South Sylhet, said to have been that of *A. sisalana*, is in the same publication reported on most favourably. Coventry gives a brief account of the Agaves in the Panjáb. [*Cf. Agri. Journ. Ind.*, 1906, i., pt. 3, 265.]

Indian-grown fibre.

Causes of Inferiority.

Retting Injurious.

Washing Advantageous.

CULTIVATION.—Indian-grown fibre has, however, been more frequently condemned than approved, but as already indicated this may have proceeded from the fibre of a worthless form having been supplied. It is true also that the condemnation may have arisen through the ignorance of the planters as to the best seasons and methods of preparation. It follows accordingly that the abundance of a species of Agave in a particular locality is no proof of commercial possibilities. The experts have, however, usually reported that the inferiority of many of the samples examined may have been due to either of two causes: (1) The leaves having been too old, thus causing the fibre to become hard, coarse and brittle; (2) The very defective method of cleaning that seems invariably practised by the Natives of India. The leaves while resting on a flat stone are crudely scraped by a knife and violently beaten every now and again in order to shake off adhering particles of cellular tissue. As a not unnatural result the fibres are broken, torn and cut short. But what is even still worse, before being scraped the leaves have often been retted for weeks, or the fibre after being separated has been soaked in water for days. As a result fermentation has been set up and the fibre discoloured, deprived of its natural polish and rendered harsh. The leaves as they near maturity, but not later, should be simply scraped by hand or by machine, then sun-dried and baled. Retting is not necessary and is distinctly injurious, but washing in a stream of water during the process of scraping is often recommended as advantageous.

Col. R. Cobb's Report.

In Bengal.—The late Mr. N. G. Mukerji (*Handbook Ind. Agri.*, 1901, 325–8) furnishes an abstract of the currently accepted views on Agave cultivation in Bengal. In the *Dictionary* will also be found a detailed report on the cultivation of this plant by Col. R. Cobb (at that time Superintendent of the Hazaribagh Jail), and since recent information regarding Bengal does not materially alter the conclusions there advanced, the original article should be consulted.

Season for Cutting.

It may in fact be said that the chief exception recent investigation would suggest to Col. Cobb's report, concerns the season when the fibre reaches maturity. Most writers affirm that when the pole has arisen from the middle of the rosette of leaves, the fibre is practically useless. It becomes too hard and brittle for manufacturing purposes. The fibre which has fetched the best prices would appear to have been obtained from fully grown leaves, but from plants that have shown no signs of producing the "candelabra-like" inflorescence. The plant grown at Hazaribagh seems to have been mainly ***A. Cantala***, but the inferior samples of Bengal fibre have evidently been chiefly procured from ***A. Vera Cruz*** (the ***A. lurida*** of some writers).

Bombay.

Assured Position.

In Bombay.—The Bombay Aloe Fibre has recently attained an assured position in commerce and is being pushed with much success. It is chiefly obtained from ***A. Cantala***, and apparently to some extent also from ***A. Wightii*** and more recently from ***A. sisalana*** and ***Furcraea gigantea.***

Soil to Fibre.

On the heavy clay soils of Bengal and Assam, as also some portions of the Central Provinces and of Madras, ***A. Vera Cruz*** might be regarded as a fairly abundant species, but on sandy loams and stony laterite soils of some parts of Bengal, the United Provinces, Sind, Rajputana, Central India and Bombay, ***A. Cantala*** becomes the most characteristic form, and is indeed met with in a state of more or less complete acclimatisation. [*Cf. Madras Mail*, Oct. 1904.] In the Panjáb its place is taken by ***A. Wightii***, of which Stewart makes the very observation regarding its prevalence in that province which Roxburgh made of ***A. Cantala*** in Bengal, viz. that it might be regarded as indigenous.

History, Central India.

N.-W. Prov.

One of the earliest descriptions of this fibre, as far as India is concerned, will be found in the Journal of the Agri-Horticultural Society of India for 1854 (viii., 148 *et seq.*) where Mr. A. R. C. Hamilton, then Resident at Indore, furnished a sample which was examined by Capt. A. Thomson at his rope-factory at Calcutta and found equal to the best Russian hemp. Capt. Thomson adds that a considerable quantity of a fibre exactly similar had lately been imported from the Malabar Coast and that he had had some made into rope which very much resembled Manila rope. Mr. Blackburn forwarded from Agra about the same time samples of fibre and rope made from "the Common Aloe," and Dr. Falconer identified the plant from which these had been prepared as ***A. Cantala***—a plant with which he had been familiar as common at Saharanpur.

Bombay.

C.-Pro

Washing.

In 1889 the Bombay Government forwarded to the Secretary of State for India a report that had been drawn up by the Director of Land Records and Agriculture on "the aloe fibre shipped under the name of 'hemp' from Bombay." This fibre, it is there stated, comes chiefly from the Bombay Karnaták and the Central Provinces. "The plant grows wild but nowhere in abundance, nor is it anywhere cultivated specially for extracting fibre." "In the Bombay Karnatak it is the chief hedge plant along railway lines. For fencing it is planted one to three feet apart according to the quality of the soil." The Director then describes the crude method adopted to separate the fibre, namely by burying the leaves in running water or amongst the sand near streams where water percolates. When sufficiently decomposed the leaves are taken out and washed clean of the pulp by beating.

Sir D. Morris, at that time Assistant Director of Kew, identified the specimens of plants that accompanied the Bombay report as confirming the fact that the "Bombay aloe fibre" was prepared from the leaves of ***A. vivipara.*** It would now seem that it was ***A. vivipara***, *Dalz. & Gibs. (non Linn), i.e.* ***A. Cantala***, *Roxb.*, according to Drummond and Prain. Sir Daniel, after suggesting that the quality of the fibre might be improved by cultivation and that it was possible *A. sisalana* might be introduced on a large scale on the waste lands of Bombay, added, "The value of the machine-cleaned fibre ranges, according to length, from £25 to £30 per ton. The ordinary Bombay aloe fibre, cleaned by hand, is worth only from £5 to £12 per ton. These figures fully bear out the opinion offered in my letter of February 21, 1887, that the Bombay aloe fibre industry was capable of being greatly improved." The subsequent history will be found in the *Kew Bulletin.* (add. ser., ii., 1898, 194–200).

Valuations.

Plantations of Bombay.—*The Englishman* (June 10, 1899) gave a long and most instructive description of Dr. E. Suter's endeavours to establish successfully the plantation owned by the Fibre Company of Powai. Another equally admirable account of the Powai plantation and factory will be found in *The Textile Journal* (Jan. 1901). We learn that Dr. Suter has obtained a 30 years' lease of 3,000 acres of land, on a rent of Rs. 14 an acre, and that he is in treaty for a further tract of land of some 20,000 acres. He employs about 500 workmen for the greater part of the year. The plantation consists mainly of *A. Cantala*, but he has put out a large number of *A. Wightii*, also of *A. sisalana* and *Furcraea gigantea.*

Method of Cleaning.

There are apparently two operations pursued in separating the fibre at his factory, during each of which a liberal supply of water is utilised. The sharp, thin extremity of each leaf is first dealt with, and when the fibre has been freed from the pulp, etc., it is washed before the lower half of the leaf is treated. The fibre of the apex of one leaf (or of several leaves treated at one and the same time) are then twisted round a small brass handle, by which means the operator is enabled to submit the lower and thicker ends of the leaves to be scraped without any risk of injury to himself. The fibre having been washed in the plentiful supply of water procured by the factory from the Powai lake, is then sun-dried. By the next process it is scutched or combed and thus turned into beautiful white threads which are assorted according to length into two qualities. Finally it is baled and is thus ready for the market. The men employed in the factory are dressed in woollen garments and gloves (supplied by the owners) in order to protect them against the acrid juice that would otherwise cause painful blisters on the skin. But Suter has also patented and is daily using a semi-automatic machine of which full particulars and photographic illustrations will be found in Mann and Hunter's pamphlet on *Sisal-Hemp Culture in India,* published by the Indian Tea Association, 1904 (22, pl. vi.). The fibre from Dr. Suter's plantation is said to fetch £36 a ton.

Acrid Juice.

II. SISAL HEMP.

Sisal Hemp.

Two Forms.

It was customary until quite recently to read of the Sisal hemp being botanically a form of the species known as *A. rigida, Miller,* and of there being two industrial forms of the species, viz. (1) *var. longifolia,* the Henequen Hemp of Yucatan, the Sacqui or Sacci (a name denoting light colour); this has the leaves spinose on the margin; (2) *var. sisalana,* the Sisal and Bahma Hemp, the Yashqui or Yaxqui (dark green); this has the margins of the leaves almost destitute of spines, but the apex ends in a conspicuous black spine. Mann and Hunter tell us that plants of the former introduced direct from Yucatan have not been very luxuriant in Sylhet, while the latter succeeds splendidly (*l.c.* 5). Drummond and Prain (*l.c.* 135) are of opinion that "there is one Sisal Hemp in this country and one only," and they add, "Leaves with and without prickles may be found on the same individual." That plant, they are further of opinion, is *A. sisalana, Perrine*, a good species and not a form of *A. rigida, Miller*.

Association with Tea.

Mann and Hunter have dealt so fully and satisfactorily with its cultivation as an associated crop with tea that it seems almost undesirable to attempt to set forth as a separate chapter their main conclusions. Persons interested in the subject of Sisal cultivation in India should most certainly procure the pamphlet mentioned. But as experience gained by others differs slightly from that in Sylhet, it may be useful to give a combined review of the practical results hitherto attained in India as a whole.

Assam.

Propagation by Seed, Suckers, Bulbils.

CULTIVATION.*– *In Sylhet.—It would seem fairly certain that *A. sisalana* is an even more tropical form than most of the Agaves and will not live if liable to seasons of frost. It may be propagated (1) by seed, (2) by suckers from the base of the stem, or (3) by "pole plants or bulbils." The last mentioned are produced from the flowering spike or "pole," and are buds formed within the bracts of the individual flower stalks. Suckers are preferred in America, and "pole plants" are largely used (if not preferred) in the Bahamas. From 1,500 to 4,000 are formed on each pole, and they do not fall to the ground until they are six inches or more in length. They root at once, and if left alone form a grass-like vegetation around the perishing parent-plant. Seeds are not so often resorted to, owing to the great delay. Morris seems to doubt the advisability of propagation from bulbils, and Mann and Hunter only recommend that course until such time as a continuous supply of suckers has been established on the estate. [*Cf.* Sly, *Agave Fibre in Assam*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 247–9.]

Distance Apart.

Number to the Acre.

Close Growing Dangerous.

Polling.

Nursery and Plantation.—The young plants, whichever way obtained, are first raised in a nursery until they attain a height of about 15 to 20 inches – Mann and Hunter say 8 to 12 inches. Shade-trees in the nursery are injurious. According to the most generally approved plan in America the young plants are transplanted into the estate, in rows 12 feet apart, the individual plants being from 6 to 8 feet apart in the rows. This will give about 650 plants to the acre, but in some estates they are planted much closer, viz. 9 to 10 × 4 to 6 feet, thus giving about 1,000 plants or more to the acre. The danger of close planting lies in the fact that during wind storms, the leaves may stab each other and thus injure the subsequent growth of the leaf and discolour the fibre. Fermentation, set up within the growing leaf or in the leaves after separation from the plant, will ruin the fibre by staining it a red colour. A writer in *Capital* (March 1901) would seem to think that the Dauracherra Estate in South Sylhet has "made no provision for a permanent crop. The plants have been planted 8 feet between in the row and 10 feet between the rows. These distances have always been recommended hitherto. When the plants got to be about four years old a young sucker ought to have been planted in between, so that when a plant poles and dies, which they almost invariably do within ten years of planting, the plant placed between would be ready to take the other's place and keep the constant supply of fibre going. But after seeing the Dauracherra plantation the writer is convinced that 8 feet by 10 feet is far too wide apart and would say 4 feet by 6 feet an ample distance." Mann and Hunter think that 5 feet between the plants and 9 to 10 feet between the rows are suitable distances for general use. Thus it may be said that overcrowding is condemned in most parts of the world

Planting Season.

where sisal planting prevails. The best time for planting is from February to June, and it is essential that the plants be pitted (not dibbled in) and that they should not be buried in the ground above the base of the leaves. They lay great stress on the latter condition; earth within the leaves, they say, causes them to rot. During the first two years the plantation requires to be hoed to such extent as found necessary to keep weeds in check.

Hoeing.

Diseases.

Diseases and Pests.—Protection from cows, deer, etc., is necessary, since if the central bud be injured the plant dies. By the third and fourth years the plants are able to defend themselves. I am informed by Mr. G. Massee that at least one fungus is known to kill the leaves, namely, *Coniothyrium concentricum, Sacc.*, and that this may often appear as discoloured patches without fructification. It would seem probable that "the discoloured spots on some of the older leaves of even very young plants" alluded to by Mann and Hunter are due to the fungus named. [Butler, *Sisal Hemp Disease*, in *Agri. Journ. Ind.*, 1906, i., pt. ii., 261.]

Cropping Season.

Indication of Ripeness.

Yielding Period.

Removal of Suckers.

Filling up Vacancies.

Cropping Season.—Much depends on the size, age and vigour of the young plants when transplanted, but they attain as a rule the condition of being able to afford a first crop of leaves in the third year, and come into full bearing in the fourth or, it may be, only in the fifth year. Leaves as a rule are ripe when they extend at right angles to the stem. Mann and Hunter say that half a right angle to the stem will suffice but none before that should be cut. The plants continue to give an annual supply of leaves till about the twelfth year, when they show signs of forming the inflorescence or "pole." Having given their crop of seed or "pole bulbils" the parent plants die and should then be uprooted. If the outer large leaves be not systematically removed year by year the plants will attain maturity at a much earlier date, say about the sixth year. Experience so far would seem to support belief that the plant will pole slightly earlier in Sylhet than in Yucatan. Mr. Woodrow reports that the sisal planted in Poona in 1892 began in 1898 to show signs of producing flowering-stems. On the other hand, it is recorded that under certain circumstances the plants may continue to yield for 15, 20 or even 25 years before the "pole" forms. In the *Kew Bulletin* (1898, add. ser., ii., 178) will be found a most interesting correspondence on the methods that might be adopted to retard polling. Sir D. Morris recommends the systematic removal of all suckers not required. It transpired (in the correspondence referred to) that the Bahamas hemp plant flowers earlier than the Yucatan hemp, a distinctly unfavourable circumstance if it be the case. As soon as the "pole" appears it has to be cut out, the remaining leaves harvested and the old plant removed. But it is customary long before this takes place to plant a seedling or sucker close by or within the interspace, so as to have a fresh plant nearing the bearing stage before the period of removal of the exhausted one has been reached. In Sylhet it has been found that the best time for cutting leaves is from October to June. This is mainly on account of the necessity for drying the fibre. The leaves are moreover less heavy at that season, an obvious advantage seeing that they have to be carried to the factory. This arrrangement fits in admirably with the associated tea industry, which calls for most labour from June to October. In laying out an estate Mann and Hunter say that owing to the enormous weight of the leaves the factory should be central and have good roads in every direction. On a small estate pack bullocks, and on a large one a light railway may be used.

Cultivation
Mysore

In South India and Mysore.—It seems that an effort is being made to organise an Agave or Sisal fibre industry of South India. We read of the South Indian Fibre Company having taken this matter up energetically. Particulars of actual plantations, however, are not available, though Mr. Tytler seems to have made a start in Anantapur district. [*Cf. Madras Mail,* Dec. 1901; *Ind. Planters' Gaz.*, Feb. 1902.] Travancore is also mentioned as a locality where the plant is being cultivated. Reference has been made to the large importation of sisal plants by the Mysore Government. Mr. J. Cameron and others (recent *Proc. Agri.-Hort. Soc. Mad.*) describe the progress accomplished. Mr. Cameron seems moreover confident that in Mysore there are many tracts of comparatively useless jungle that possess the requisite soil for Sisal cultivation. He also tells us of having sold sufficient young plants to cover the cost of importation of the original stock. The experience gained he summarises thus:—

Experience Gained.

1. Land of a gravelly soil and stony nature is most suitable.
2. When it is planted, cultivation practically ceases for a period of four years or until the matured leaves are ready for cutting.
3. On suitable land, failure of crop has never been heard of.
4. The profit of a cropped acre is estimated at £4 to £5 per annum—that is, 60 to 70 rupees.

Profit.

On this subject Mann and Hunter observe that the Sisal does not require a rich soil. It must have a soil well drained, moderately light and not too rich since that leads to luxuriance but loss of fibre, nor too poor since the fibre will then become short. The presence of lime in the soil is advantageous. In a word, much of that culturable land in tea districts which is not suited for tea will do well enough for Sisal. But it would appear these authors may have been led into the expression of a too emphatic opinion as to Sisal being not only the best but the only species suited to the tea districts (Mann and Hunter, *l.c.* 4, 9). It seems highly probable that the liability to frost, to which not a few tea districts are subject, might preclude the cultivation of Sisal and point to ***A. Cantala***, for example, as preferable. Of course where it is found possible to grow ***A. sisalana*** that would be the best species, but there seems no doubt that for the whole of the tea districts, and still more so for the whole of India, one and the same species is not universally suited. [*Cf. Ann. Rept., Bot. Gard. Sibpur,* 1903-4.]

Frost an Important Factor.

Bombay.

In Tirhut and Bombay.—Although a good deal has been written in a general way regarding the Tirhut and Bihar ventures, little definite knowledge is available such as to justify the formation of opinions regarding either the methods pursued or the success obtained. It is known that large shipments of plants have been secured, and it is understood that they have taken kindly to the climate and soil of Bihar. Frequent mention has also been made of Mr. Woodrow's experiments and results and of his endeavours to establish plantations at Nasik and Nandgaon. In the prospectus of the Bombay Sisal Hemp Co., Ltd. (issued in April 1899), Mr. Woodrow says, "I introduced a few sisal hemp plants seven years ago; they have grown remarkably well and have given 10,000 young plants." Further on he adds, "One million aloe fibre plants are at hand, enough for 500 acres, and about 10 millions are procurable this year." In the same way it is known that Dr. E. Suter is growing Sisal at Powai, near Bombay.

But as already shown, the plant cultivated on that estate is chiefly *A. Cantala.*

Smaller Plantations.

While these brief references denote what might be called the more important centres of the new Indian Sisal hemp enterprise, particulars of small experimental plots are to hand from every province of India and Burma. The reader should consult Prain's Report for additional particulars (*Agri. Ledg.*, 1900, No. 6).

Fibre to Leaf.

Number of Leaves.

Yield of Fibre.—Of Yucatan it is said that from 1,000 to 1,500 lb. per acre of cleaned fibre are obtained and that 50 to 70 lb. are derived from 1,000 leaves of plant. This would come to an average of about 30 leaves yielded by each plant, in order to give the amount of clean fibre stated ; but most reports place the produce at a much lower figure, namely from 10 to 20 leaves a year for each plant. We read that in Lucknow, grown on a poor soil, the plants are said to have had 30 leaves ; 50 in Saharanpur, Cachar, Tirhut ; 60–70 in Port Blair ; 72 in Assam ; and 80 in Poona. Doubtless these numbers have reference to the total leaves on each plant, not to the number of mature leaves annually available for fibre extraction.

Manufacture.

Method of Cutting.

A Day's Work.

Length and Weight of Leaf.

Harvest and Fibre Extraction.—The leaves are cut off from the stem from below upwards by means of a heavy-bladed long knife, and the spine on the apex is also severed by a blow of the same before the leaves are thrown on the ground. In America and the West Indies the operators are paid as a rule by contract, but a day's labour would be regarded as from 2,000 to 2,500 leaves. According to Indian experience the leaves are approximately 4 feet 6 inches long and 5 inches wide with a weight of 2 lb. Some are recorded as only 2 feet long by 3 inches and weight 5 ounces ; others 6 feet 6 inches long by 5 inches wide and 2¾ lb. in weight. The Sylhet experience would be about the mean of the figures given. " True Sisal hemp, grown on suitable and not too rich land, should yield for instance, 3 per cent. of fibre (and often much more) on the weight of leaf : careful tests of the large blue Aloe in India have given 2½ per cent. only of fibre. ***Furcræa gigantea*** (Mauritius hemp) gives a still less yield on the weight of leaf, the amount being in Sylhet from 1¾ to 2 per cent., but in this case the difference is more than counterbalanced by the larger weight of leaf obtained per acre."

Machinery.

Machinery.—The most generally used fibre-cleaning machine in Yucatan is called the " Raspador," although others are employed, such as the " Solis," " Preito," " Torruella " [*cf.* photograph in Mann and Hunter, *l.c.* 24, pl. vii.] and " Villamore." The " Raspador " [*cf.* Mann and Hunter, *l.c.* 21, fig. 2] consists of a drum with brass knives fastened across the face. It is so geared as to revolve about 110 times a minute. The leaf is held by a clamp and crushed as it moves forward, while the pulp is scraped off by the knives as they dash across it. When little more than one-half the leaf has been reduced to pulp it is withdrawn and reverses so that the other half may be similarly cleaned. The fibre is then dried in the sun and baled for export. Though crude in construction the " Raspador " has the advantages of cheapness and simplicity. It is typical of most of the modern machines that have been brought out, each with special claims to superiority over the others. With ***Furcræa gigantea*** the " Gratte " machine is in a position of supreme favour. But in addition to the machines already mentioned, the following may be said to have been specially designed to deal with the aloe fibres :—the " Death," the " Barraclough," the " Van Buren," the " T. Abee Smith," and the " Weicher " machines. Then there is the " Silburn " machine of which so much has been said in the Indian Press recently, and lastly the " Suter " machine, which makes 500 revolutions a minute.

" Gratte " Machine.

Various Machines.

Properties and Uses of Sisal and Aloe Fibres.—I have not thought it necessary or desirable to devote space to the discussion of these subjects. Briefly the fibres are used for ropes and cordage ; for carpets, mats and matting ; for brush-making ; and the waste for paper-making. To a limited extent the shorter and finer fibres are carded, spun and woven. [*Cf.* Royle, *Fibrous Pl.*, 1855, 41–50 ; *Agri. Ledg.*, 1896, No. 34 ; Dodge, *Useful Fibre Pl. of the World*, 1897 ; Stuhlmann, in *Der Pflanzer*, 1907, Nos. 15, 16, 229–43 ; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 96–8.]

Industrial Applications.

Earliest Records.
Exports from Yucatan.
Profitable Price.
Limited Possibilities.
First Sales.

TRADE IN HEMP.—Mann and Hunter give interesting particulars regarding the prospects of a Sisal Fibre Industry: the capital required, the world's markets for the fibre, prices ruling, etc., etc.; their work should be consulted for such particulars. One of the earliest records of this fibre refers to the imports into England from Yucatan from 1750 to 1780. Although high expectations were then raised, the fibre did not assume a position of importance until fully a century later, when the first plantation of some 50 acres was laid out. The exports from Yucatan were 243,968 bales in 1889 and 418,972 bales in 1898. It is said that in the latter year there were 1,200 plantations in Yucatan alone. It seems probable that in the Bahamas there are over 20,000 acres under the crop. According to Sir W. Robinson (lecture in March 1900 before the Royal Colonial Institute of London), so long as the fibre fetches even £20 to £25 a ton the prospects would be distinctly favourable for the investor in the West Indies. Were it not necessary to provide for heavy charges in supervision, for rent of land (as a rule too valuable for the crop), for freight charges in many instances over long distances to the seaboard, the cheap labour of India might be a factor of no small importance. But it cannot be denied that there are large tracts of India highly suited for this plant which are at present practically waste. As an auxiliary crop with tea and when grown on land near the seaboard, it is very probable that success would be attained. But the industrial developments possible for this fibre seem to be comparatively limited. Moreover, indications are not wanting that the increasing production is at a higher rate than the expansion of the demand. But that a limited Indian cultivation might be successful seems fully demonstrated by the results already attained. It may be of interest to add that the first public sales of Sylhet Sisal fibre show that it fetched £36 10*s*. per ton in London or approximately the same price as realised for the Bombay Aloe fibre, so that the difference in species grown does not appear materially to have affected the value of the fibre produced. [*Cf. Ind. Plant. and Gard.*, Feb. 21, 1901.]

Indian Market.
Brush-makers' Fibre.
Reju Fibre.
Imports.

To what extent production is meeting the existing Indian demand cannot at present be discovered, but there would seem to be no doubt that steadily the Indian supply will improve, and the most recent information goes to show that most encouraging results have been attained in Assam (Sylhet). It is known that there is a regular import trade in "white fibre" to be used by the rope-makers in place of or in mixture with the more expensive Manila Hemp. Certain qualities of sisal or other aloe fibres are also used by the brush-makers. For brushes the larger, thicker, more elastic and more highly polished fibres are required, since these approximate most nearly to pig's-bristle. In the Calcutta market a specially selected fibre for the brush-making trade is reported to be sold under the name of *reju* and to be imported from England. But here it may be added that the *Ixtle* or *Tampico* fibre (*Agave heteracantha*) is a Mexican fibre which might be said to be specially produced for the brush-maker. How far this may be the *reju* fibre of India cannot at present be ascertained. Nor can definite returns of the Indian trade in sisal fibre be given, since both the import and export traffic is recorded under the collective heading of "Hemp." Out of the total imports of "Raw Hemp" from foreign countries received by India in 1906–7 (viz. 22,513 cwt., valued at Rs. 6,94,623), China supplied 14,815 cwt., the Philippines 4,891 cwt., the

United States 1,635 cwt., New Zealand 758 cwt., and the United Kingdom 209 cwt. The nature of the fibres classified as "Hemp" in these returns can be judged of only by the countries from whence derived. Thus the Philippine Hemp may in all probability have been Manila Hemp: the supply from that country was renewed in 1899–1900. Perhaps the most striking feature of these imports of hemp is the decline in the supply from the Straits, which in 1896–7 fell from 6,624 cwt., valued at Rs. 1,01.831, to 370 cwt., valued at Rs. 10,796, in 1905–6, and in 1906–7 *nil.* The EXPORTS from India are mainly, if not entirely, of "Sunn Hemp" and other allied fibres, and thus quite distinct from the "Sisal Hemp" here dealt with, so that the returns of exports need not be further considered. But it is believed that about 25 per cent. of the exports of Raw Hemp from Bombay are at the present time Aloe (Agave) fibre. In 1906–7 Bombay exported 255,375 cwt. of Hemp, valued at Rs. 28,74,499. And a striking feature of the exports of raw hemp is the fact that the Bengal section appears to have given an indication of expansion, a consequence, doubtless, of the Sylhet production of Sisal. In 1899–1900 Calcutta exported 63,433 cwt., valued at Rs. 4,66.503, in 1900-1 an expansion to double the quantity and three times the value was recorded, viz. 128,634 cwt., valued at Rs. 12,20,351, and in 1906-7 to 261,867 cwt., valued at Rs. 29,76,541.

Manila.

Exports.

Bengal Traffic Expanding.

ALBIZZIA, *Durazz.*: *Fl. Br. Ind.*, ii., 298–302; Gamble, *Man. Ind. Timbs.*, 302–9; Cooke, *Fl. Pres. Bomb.*, i., 452–5; Duthie, *Fl. Upper Gang. Plain*, i., 319–22; Brandis, *Ind. Trees*, 269–73; Prain, *Journ. As. Soc., Beng.*, lxvi., pt. ii., 511–5; LEGUMINOSÆ.

D.E.P., i., 155-60.

There are in India 14 species of this genus, all trees except one. Lt.-Col. D. Prain in his revision of the genus has added four species not hitherto separately recognised and has removed much of the ambiguity that previously prevailed. He has shown that Indian authors have been in error in thinking that ***A. Julibrissin*** is met with in India: he has restored ***A. mollis***, *Boiv.*, to specific importance, and separated from ***A. Lebbek*** (under the name ***A. Gamblei***) an important East Himalayan form. Generically the species of ***Albizzia*** bear the vernacular names of *siris, sirisha, sirin, turanji, chirugu, baghi, vaghe, kokko*, etc. ***A. Lebbek*** seems to be the true *siris*, a tree, according to Sir Monier Williams, that is sacred to the Buddhists. The other species are distinguished as the sweetly scented *siris*, the white *siris*, etc.

Botany.

They all afford GUM, more or less copiously, from wounds on the stem, and though little is known for certain of the specific differences of these gums, that of ***A. stipulata*** is reputed to be specially valued as a size in the manufacture of Nepal paper. The barks of most species are astringent and used as DYES, TANS and MEDICINES. That of ***A. Lebbek*** is employed in Madras to tan fishing nets, and that of ***A. myriophylla*** (*kanta-siris*) is utilised as a substitute for ***A. leucophlœa*** in distillation, and those of ***A. stipulata*** and ***A. procera*** are said to be fish poisons. The leaves of most species are regarded as useful FODDERS and in some instances the trees are specially grown on that account, but according to Mr. Hartless the stipules and young leaves of ***A. stipulata*** are poisonous to cattle. The most curious discovery regarding the leaves of this genus may be said however to be the determination made by me of the so-called JYREE Tea, which consists of ordinary tea mixed with specially prepared leaves of ***A. amara*** (the *lalai* or *unjei*). [*Cf. Journ. Agri.-Hort. Soc. Ind.*, 1898, xi., 838–42; 1899, 982–3; *Kew Bull.*, 1899, 82.] Mr. Chandra Bhushan Bhaduri, Officiating Chemist to the Industrial Section, Indian Museum, analysed ***A. amara*** leaves (hand-picked from a sample of *jyree* tea) and found that they possessed no special properties worthy of notice. [*Cf. Ann. Rept. Ind. Mus.*, 1899–1900, 52; *Pharm. Journ. Gt. Brit.*, Dec. 16, 1905, 833.]

Gum.

Dyes, Tans and Medicines.

Fodder.

Jyree Tea.

The TIMBER of these trees varies greatly, being very soft in ***A. stipulata***, hard in ***A. odoratissima, lucida*** and ***amara***; sapwood large and white; the heartwood light to dark-brown, streaked, shining; pores usually scanty and often

Timber.

East India Walnut.

subdivided, showing up prominently as dark streaks on vertical section; lastly the medullary rays are fine, short-distant and shallow. Recently ***A. Lebbek*** has found its way to Europe under the name of "East Indian Walnut," being exported mainly from the Andaman Islands. [*Cf. Handbook Imp. Inst.*] It grows rapidly, seasons, works and polishes well, and is fairly durable. It is said to be taxed in Burma at a higher rate than teak-wood, a circumstance that indicates the local value put on this timber. It is used for agricultural and industrial instruments and appliances, for furniture and picture frames, and cartwrights' work, etc. The timber of ***A. amara*** is very much like that of the *Siris* only that it is purplish-brown with concentric light and dark bands. [*Cf. For. Admin. Rept. Mad.*, 1897–8, app. i., 31.] The timber of ***A. odoratissima*** turns almost black with age, is largely employed for cart-wheels, etc. Lisboa says that the wood of ***A. procera*** has darker patches, but that it takes a fine polish and is recommended for furniture. [*Cf. Useful Pl. Bomb.*, 1884, 70, etc.]

Avenue Trees.

Tea and Coffee Shade-trees.

As Avenue and Shade-trees most of the species are much admired. ***A. lophantha*** is a rapid-growing tree, introduced from Australia and completely naturalised in the Nilgiri hills. ***A. moluccana*** is another introduced species, and one of the most stately and beautiful members of the genus. It was at one time much cultivated by the coffee-planters of South India, but has got into disfavour for that purpose because of the immense size it ultimately attains. ***A. procera*** has been specially commended for cultivation on saline soils. [*Cf. Ind. For.*, 1887, xiii., 339; 1888, xiv., 142; *Ann. Rept. Dept. Land Rec. and Agri., Beng.*, 1891–2, 23.] It is the species that first appears on the sandy beds of rivers. But by far the greatest interest in the species of ***Albizzia*** centres in ***A. stipulata***, which is now very extensively grown as a shade-tree for tea, both in Assam and Darjeeling. It is known as the *sau* in the former province and the *kala-siris* in the latter. Its chief value turns on the nitrating warts formed on its roots. [*Cf.* Watt and Mann, *The Pests and Blights of the Tea Plant*, 140; *Der Tropenpflanzer*, 1901, v., 244.]

D.E.P., i., 162 4.

ALEURITES FORDII, *Hemsl.*, *Kew Bull.*, 1906, 117, 120; Hooker, *Ic. Pl.*, tt. 2801, 2802 (confused with ***A. cordata*** by most authors); Euphorbiaceæ or Spurgeworts. A small tree, native of China but successfully acclimatised in the Southern Shan States (between 1,500 and 3,000 feet in altitude) and to some extent also in Burma, Assam, Sikkim and Nepal. Frequently met with near Buddhist monasteries, though in some localities it appears to have escaped into the neighbouring jungles. ***A. cordata***, *R. Br. ex Steud.*, has a wrinkled fruit and is found in Formosa, Hainan and Tonkin and is cultivated in Japan.

Oil.

Trade Names.

Drying Property.

Lubricating Oil.

A. Fordii yields an Oil known in commerce as Chinese Varnish or Tung Oil and in some books is spoken of as Chinese Wood Oil, the latter name referring to its special adaptability for varnishing wood (see p. 502). In fact the Chinese prefer to coat boats and other woodwork with this oil rather than to paint them. It dries in about four hours. It is chiefly prepared in the provinces of Ichang and Szechuen and is employed in lacquering, varnishing and waterproofing, etc. The drying property of the cold-expression oil exceeds that of any other known oil; in fact it would appear to be an exceedingly valuable substance, the properties of which have been but indifferently appreciated in Europe. Of Japan it is said that the tree flowers at the end of May or beginning of June. The fruit ripens in autumn. Three to five seeds are contained in each fruit; they afford an oil to the extent of 37½ per cent. which is pressed out, in ordinary practice cold, to the extent of two-thirds of the possible yield. This oil, known in Japan by the name of *Dokuyenoabura*, serves for filling the pores of wood before it is coated with lac, or it is used when desired to protect wood against moisture. In Japan it is also employed for lubricating machinery.

Existence in India.

Method of Preparation.

A recent inquiry in India into the species that follows, led to information being procured from the Southern Shan States regarding the present plant. It would appear that in Kengtung the tree is fairly plentiful and the oil regularly prepared, although the demand is but limited. It has been estimated that the nuts of each tree might yield at least 50 ounces of oil. The kernels are first pounded, then steamed in a basket placed over the mouth of a pot in which water is boiled. The basket is next placed within a piece of bullock's skin and the whole deposited in the oil press and compressed. The oil escapes into a vessel placed below for its reception. It is much more highly appreciated than the oil of the next species. It is known in Kengtung as *makyauhkai*, and near Fort Steedman as *kanyin*. In the *Kew Bulletin* will be found particulars of the recent imports into Europe and America of this so-called wood-oil.

Local Names.

It is specially valued for use, along with vermilion, in the preparation of the much admired paint (with its richly glossy surface) so frequently seen at the monasteries (*wats*) and pagodas of Burma. It is also employed as a VARNISH for lacquer-work (especially the finer trays, betel-nut boxes, etc). It is said that in the Southern Shan States the tree grows quickly and is readily propagated by seed. A tree 5 years old attains a height of about 16 feet, and when about 8 to 10 years old it comes into full bearing. The fruits ripen in October, or about three months later than those of the next species. It is believed that were a remunerative demand to arise, in a very few years the supply from these States might be practically limitless, and Prof. Warburg is of opinion that the oil should supersede linseed oil on the European market. [*Cf.* Hosie, *Three years in Western China*, 1890, 18; *Journ. Chem. Ind.*, 1896. xv., 284; *Journ. Soc. Arts*, 1897, 45, 1184; *British and Colon. Drugs*, May 20, 1898, 654; Semler, *Trop. Agrik.*, 1900, ii., 533-6; Jumelle, *Les. Cult. Colon.* (*Indust.*), 1901, 118-21; *Chemist and Druggist*, May, 1902.]

Vermilion Paint.

Varnish.

Season.

A. triloba, *Forst.*: Hemsley, *l.c.* 121; *A. moluccana*, *Willd.*; *Fl. Br. Ind.*, v., 384; Gamble, *Man. Ind. Timbs.*, 613. The Indian or Belgaum Walnut, the Candle-nut; the *jangli-akrot*, *jaiphal*, etc. It occurs practically throughout India and Burma, but nowhere plentifully except perhaps in the Malay Peninsula. It has been stated to be wild in the Wynaad, because of its greater abundance in that country, but it is certainly not indigenous to India, and, in fact, usually exists as a garden or roadside curiosity, especially near towns or villages. On the eastern side of India the fruits ripen from June to August (Roxb., Kurz., etc.), and on the western side not until the cold season (Talbot).

D.E.P., i., 163.

Belgaum Walnut.

Habitat.

The nuts are commonly said to contain 50 per cent. or more of a sweet edible OIL. [*Cf.* Dymock. *Mat. Med. Western Ind.*, 713.] It is much appreciated for illuminating purposes and is said to be largely exported from Polynesia and used in the candle trade of Europe. The kernels are sometimes strung on thin bamboos and burned as natural candles, a circumstance that has given origin to the name of the Candle-nut tree. Capt. Champion (*Agri.-Hort. Soc. Ind.*, Corresp. and Select, 1843, ii., 383 *et seq.*) described the preparation of the oil from these nuts as then practised in Ceylon, and tells us that it was being exported from that country under the name *kekune*. During the succeeding half century, the Journals of the above Society, as also the pages of the Indian press generally, have spasmodically urged the importance of this tree on the attention of the Indian people, but with very little practical results.

Oil.

Natural Candles.

Ceylon Traffic.

The inquiry during the past decade has revealed the fact that the tree exists here and there all over the country, but nowhere in such abundance as to admit of any expectations of an immediate TRADE in the oil. In fact, with the exception of the Shan States, the oil does not appear to be expressed from the kernels anywhere in India. In some parts of Burma it is employed as a VARNISH with lacquer-ware, but it is usually stated that for that purpose it possesses no special advantage over *Sesame* or *Sarson* oils.

Prospects of Trade.

Varnish.

There are two directions of study that should engage attention in the future: (*a*) The method of preparation of the oil or oils of these trees, best calculated to bring out their special features of value. (*b*) The yield and profit, in connection with the regions that give indications of greatest success.

Future Inquiry.

ALKALIS, ALKALINE EARTHS, ALKALOIDS, etc.—It would be beyond the scope of this work to deal with the substances indicated by the heading given to this article with any pretence to completeness, but they could not be omitted since it might almost be said that the industrial progress of a country can be ascertained by the extent to which it produces the *Alkalis* required by it own industries.

Alkalis.

ALKALIES AND ALKALINE EARTHS

Classification.

In its restricted sense the term *Alkali* might be said to denote AMMONIA, POTASH, SODA, LITHIA—the alkalis proper. But in a wider signification it embraces the ALKALINE EARTHS, viz. the hydrates of the metals BARIUM, CALCIUM and STRONTIUM. These all possess to a certain extent the properties usually attributed to the alkalis. In like manner the ALKALINE ASHES are very largely crude alkalis obtained by burning certain plants. Lastly the ALKALOIDS such as ACONITINE, MORPHINE, QUININE, etc., have been described as the ORGANIC ALKALIS, but of course have nothing alkaline about them.

Distinctive Features.

The distinctive features of the alkalis compounds may be said to be their solubility in water, their neutralisation of acids, their corrosion of animal and vegetable substances, and lastly their property of changing or inverting vegetable colours, such as litmus.

Indian Crude Methods.

In all fairness it may be said of India that it does not possess any industry (pursued on modern scientific methods) for the production or refinement of the alkalis, alkaline earths and their salts. Such manufactures as do exist (if common salt be for the moment left out of consideration) are a century behind the times, and consist mainly in the production of saltpetre, pearl-ash, barilla and the like.

Materials here dealt with.

It is intended in this place to deal more particularly with the collective aspects of the alkalis and alkaline earths and to discuss, in such detail as may be necessary, the minor products, but with those of commercial value, simply to indicate the positions where separate articles on these will be found.

D.E.P., i., 219-20. Ammonia. Not Manufactured in India.

ALKALIS.—1. Ammonia and its Salts.—This alkali is in Europe and America very largely prepared from "gas liquor" (see **Coal**, p. 344) or "bone liquor" or from "volcanic salts." It is not manufactured to any appreciable extent in India, for the simple reason that none of the crude materials named are to be had in sufficient abundance.

Essence of Ginger. Hatters' Varnish.

The chief preparations and salts are (*a*) LIQUOR AMMONIA used as medicine, as a chemical and as a solvent for resins and for certain active vegetable principles, thus forming varnishes and ammoniated tinctures. Of the latter class may be mentioned the "Essence of Ginger," employed in the manufacture of gingerade and ginger beer; of the former the Hatters' Varnish, which consists of shellac dissolved in ammonia and alcohol.

The salts are (*b*) the CHLORIDE (*narasára* or *nausadár*), of importance as a material from which to manufacture other salts of ammonia, also essential in galvanising, in galvanic batteries and as an alkaline flux. (*c*) The SULPHATE, which is largely employed as a manure (see **Coal and Coke**, p. 346). [*Cf.* Mollison, *Textbook Ind. Agri.* i., 117.] (*d*) The CARBONATE, SULPHIDE, OXALATE, NITRATE, PHOSPHATE and BROMIDE, all of which take important places in the arts and industries of every country and may be said to be entirely imported by India.

D.E.P., i., 167; ii., 152-4; vi., pt. i., 332. Potassium. Pearl-ash. Vernacular Names.

2. **Potassium or Potash and Carbonate of Potash.**—J. H. Brough, *Cantor Lectures* in *Journ. Soc. Arts.*, 1903, lii., 144. This is the chief source of CAUSTIC POTASH, and the two compounds may, therefore, be dealt with collectively in this place. The carbonate in its crude form is often called POTASHES or PEARL-ASHES and in Bengali *sarjika*, in Hindustani *jon-khar* or *ivak-chár*, and in Sanskrit *Yavak-shára.* Of the other provincial names the following may be quoted :—*jhar-ka-namak, jhadicha-mitha, mara-vuppu, manu-vuppu, búdide-vuppu, káram,* etc.

Sources.

Sources.—Formerly the European supply of the crude material from which this substance is manufactured was very largely the PEARL-ASH or WOOD-ASH obtained from America, Canada and Russia, etc. While the production of pearl-ash has steadily declined with the advance of traffic in more scientific and less wasteful materials, the imports into Europe of pearl-ash have not been entirely discontinued. Caustic potash is usually manufactured from the carbonate, and

Manufacture.

this is procured:—(*a*) From the ashes of plants. (*b*) From the soil (due to the disintegration of felspar and other silicates and the ultimate combination of their potash with carbonic acid), also numerous methods patented for the accomplishment of this same result artificially. (*c*) From the potassium sulphate, produced by the decomposition of the chloride through the agency of sulphuric acid followed by fusion of the resulting sulphates with limestone and charcoal, in other words a process almost identical with the Le Blanc method of treating soda. (*d*) From suint or the wool of sheep impregnated with the sweat that exudes from the bodies of the animals. (*e*) Beet-root vinasse.

Roxburgh's Views.

Roxburgh's statements regarding the production of pearl-ash are amusing and interesting (*Fl. Ind.*, ii., 62). I shall quote his own words. "Our extensive, and I may also say impenetrable forests, which cover such large tracts of the best lands in India might by degrees be cleared and turned into potash, for the same reasons and by the same means" as the saltworts of the coast might yield barilla. "Certainly, labour is as cheap here as in Russia." "In this hot climate we have many advantages, viz. immense tracts of wood of the most solid texture which require little labour to prepare it for the fire, on account of the great drought and heat which prevail at the season this manufacture could be best carried on. The same heat and drought is fully sufficient to evaporate the ley without the least assistance of fire." "Our extensive and impenetrable forests" sounds remarkable when it is borne in mind that one of the reasons assigned at the present day for the recent expansion of the area of carbonate of soda impregnated sterile soils is the absence of forest. We know as a matter of trade history that India never actually burned her forests in the production of pearl-ash. Moreover, Roxburgh's "impenetrable forests" had very possibly no reference to Northern India. Still his remarks are significant since he was one of the best informed and most careful observers and at the same time one of the most accurate writers who ever lived in India. His words cannot, therefore, be placed on one side as unworthy of consideration. They doubtless denote that 100 years ago forest was very much more plentiful than at the present day and was possibly ruthlessly destroyed to make room for temporary cultivation.

Impenetrable Forests.

Yield in Various Plants.

Of plants it may in general terms be said that herbaceous annuals contain more pearl-ash than woody arborescent plants, but even of the same plant the succulent young growths are more highly charged than mature tissues. Of different species 1,000 parts of pine contain on an average only 0·45 parts of potash, oaks 0·75, vine shoots 5·50, ordinary straw 5·8, ferns from 4·25 to 6·26, Indian corn-stalks 17·5, nettles 25·03, wheat straws before earing 47·0, wormwood 73·0, and beet about the same amount. These facts naturally suggest the plants best suited for the preparation of pearl-ash, and the immense development within recent years of the beet-sugar industry at once awakened an interest in carbonate of potash as a by-product that might supplement the returns of beet cultivation. This has been actually turned to account.

Carbonate of Potash—a By-product in Beet-sugar.

Plants used in India.

Indian Pearl-ash.—The following may be given as the principal plants employed in India for the preparation of pearl-ash:—

Achyranthes aspera.
Adhatoda Vasica.
Alstonia scholaris.
Amarantus spinosus.
Bamboo spp.
Borassus flabellifer.
Butea frondosa.
Cæsalpinia Bonducella.
Calotropis gigantea.
Cassia Fistula.
Cedrus Deodara.
Erythrina indica.
Euphorbia neriifolia.
Euphorbia Tirucalli.
Gmelina arborea.
Holarrhena antidysenterica.
Hordeum vulgare.
Indigofera tinctoria.
Luffa ægyptiaca.
Musa sapientum.
Nerium odorum.
Pennisetum typhoideum.
Plumbago zeylanica.
Pongamia glabra.
Shorea robusta.
Stereospermum suaveolens.
Symplocos racemosa.
Terminalia belerica.
Vallaris Heynei.
Vitex Negundo.

Crude Indian Alkalis.

The crude ashes obtained from the above and such-like plants are the chief sources of the potash salts employed by the people of India in their arts, science and medicine.

Uses.—In Europe carbonate of potash is largely in demand for the manufacture of certain soaps, after having been converted into the caustic. It is also essential in the formation of potash-glass and enters into many tinctorial and textile processes, such as the dyeing of Turkey red and of Arnotto (***Bixa Orellana***).

Soap and Glass

Turkey-red Dyeing.

In Garhwal hemp-fibre is boiled before being bleached (see ***Cannabis sativa*, Fibre**, p. 255). In India it would be almost impossible to over-estimate the extent to which a crude carbonate of potash is employed. A better selection of plants or improvements in the methods pursued for the production of pearl-ash are subjects, therefore, of no small importance. It may accordingly be remarked that it is surprising that while immense tracts of mountainous land are in India injuriously covered with various species of wormwood (***Artemisia***), except as a manure used locally the ashes of these plants are not apparently utilised by the people. From the high percentage of carbonate of potash which they contain, the preparation of pearl-ash from wormwood might be confidently recommended to the poorer inhabitants of the temperate regions of India as a useful new industry.

A Useful New Industry.

Rabing Soil.

In Bombay, especially in the rainy tracts, the system prevails of *rabing* (as it is called) the seed-beds. This consists in burying brushwood, boughs of trees, cow-dung, etc., under a thin layer of soil, then firing the mass. In this way the soil becomes highly charged with wood-ashes, the most important constituent of which is doubtless potash. It is found that the finer qualities of rice can alone be grown when the seed has been previously germinated on *rab*-beds, and later on transplanted to the fields. It would be well, in connection with the subject of potash as a manure, for the reader to consult Leather's admirable papers on Indian Manures. [*Cf. Agri. Ledg.*, 1897, No. 8; also Indian Soils, 1898, No. 2; Mollison, *Textbook Ind. Agri.*, i., 83–5, 119–21.]

3. **Potassium nitrate** (see **Saltpetre**, pp. 972–5).

D.E.P., ii., 154.

4. **Sodium and its Compounds, Carbonate of Soda;** Ball, *Man. Econ. Geol. Ind.*, 1881, 492–7; Holland, *Rec. Geol. Surv. Ind.*, i., 115. The term soda, strictly speaking, denotes the oxides of the metal, but it is also used for the hydroxide and the carbonate. The last mentioned is not only the most important commercially, but it is the compound from which the majority of the other soda salts are made or can be made, and therefore it may be dealt with in greatest detail.

CARBONATE OF SODA is a valuable salt; it exists in nature and is, as a rule, the most abundant and, from the point of view of the agriculturist, the most objectionable ingredient of the soluble sodium salts found in the soil. This subject will be dealt with in a further paragraph under the heading of *Réh* deposits (see below). It may be here observed that from such deposits carbonate of soda can be isolated and purified commercially, or a crude mixed salt can be made that might be utilised in the manufacture of special alkalis or in the glass, soap and other trades. Sodium carbonate in an even purer state may be obtained from the brine of certain lakes, such as the Lonar in Berár.

Kelp and Barilla.

Manufacture from Kelp.—In Europe some few years ago a large trade used to exist in the separation of sodium carbonate from calcined sea-weeds—KELP, or salt-worts—BARILLA. Indeed to this day it may be said that SALSOLA SODA is still regularly produced both in France and Spain because of the large amount and fine quality of soda obtained from its ashes. And it was the loss of their regular supplies of barilla, during the wars with Spain, that compelled the French people to seek for new sources of the salt and finally led to Le Blanc taking out a patent in 1792 for the artificial manufacture of carbonate of soda from common salt. Le Blanc's discoveries practically revolutionised the chemical works and industries of Europe (see pp. 50–1). The calcination of sea-weeds is pursued as a rule for the purpose of obtaining potash rather than soda, and at the present day "kelp" is much more frequently spoken of as the source of IODINE than of either of the alkalis named. [For particulars regarding the manufacture from Sea Salt the reader might consult *Agri. Ledg.*, 1902, No. 5.]

Origin of Le Blanc Discovery.

Iodine.

Sulphuric Acid.
Copper Pyrites.
Sulphur.
Prospects

One of the greatest economies in the carbonate of soda industry was effected by the manufacture of SULPHURIC ACID from PYRITES, in place of from the expensive Sicilian SULPHUR. The extensive deposits of copper pyrites that exist in India, if utilised in the combined production of copper and sulphuric acid, should open a highly lucrative field of enterprise. So also the manufacture of the phosphatic deposits of India and adjacent countries into superphosphates should not be neglected, though so far as at present known the phosphatic deposits of India seem to contain too much iron and alumina to make really good superphosphates. As an exemplification of such results it may be remarked that the production of sulphuric acid from iron pyrites was in Germany 358,149 tons in

1882, and 754,151 tons in 1898, and of that large quantity only 25,000 tons were exported, the balance being used up in the exceedingly important German chemical industries which within the past three-quarters of a century have expanded from being nominal to a valuation of £50,000,000. The imports of sulphuric acid taken by India have averaged from 1902 7 Rs. 6,58,488 in value.

Sulphuric Acid.

For the finer sorts of glass, and for many other minor purposes, a Refined Carbonate is required. This is obtained by re-dissolving the ash in hot water, settling, boiling down and re-furnacing—the result being a purer quality of carbonate. Soda Crystals may be said to be a well-known special preparation that contains 10 parts of water in combination with the carbonate. For household purposes of cleaning, bleaching, etc., soda crystals are still sold. The other substances obtained from sodium carbonate that may be here mentioned are the bicarbonate of soda and caustic soda. Before proceeding to deal with the last mentioned, the Indian manufacture and sources of supply of carbonate of soda may be dealt with very briefly. These have already been incidentally mentioned, namely, *Réh* and *Barilla*, but to the former must be added the sources of natural carbonate derived from the waters of certain lakes, such as the Lonar in Berár. [*Cf.* Oldham, *Man. Econ. Geol. Ind.*, 19.]

Glass.
Refined Soda.
Soda Crystals.
Bicarbonate.
Indian Supply.

5. **Réh or Sajji-matti**; Ironside, *Phil. Trans.*, 1774, lxiv., (ed. xiii.), 506; Sleeman, *Tour through Oudh*, 1858; *Agri. Ledg.*, 1893, Nos. 12, 13; 1896, Nos. 1. 33; 1897, Nos. 5, 7, 13; 1901, Nos. 4, 13; 1902, No. 5, 117–24; Oldham, *Man. Econ. Geol. Ind.*, 1893, 447; Mollison, *Textbook Ind. Agri.*, i., 77–80; Wedderburn, *Drought-resisting Fodder Plants*, in *Ind. Famine Union Leaflet*, Dec. 1901, No. 2; Jan. 1903, No. 8; *Alkali Land and its Reclam.*, in *Dept. Land Rec. and Agri. Mad.*, 1905.

D.E.P., vi., pt. i., 400-27.
Réh.

This is an efflorescence that occurs on the surface of the ground, in most provinces of India. It may be said to be a mixture of the following salts:—sodium carbonate (*sajji*), sodium sulphate (*khari*), and sodium chloride (common salt or *namak*). In most localities the carbonate predominates but in others the sulphate, and in the latter case it is very often associated with potassium nitrate or even with calcium nitrate. Soils badly impregnated with soluble alkali salts are variously designated as *úsar*, *bhádi*, *réhál*, *réhár*, *réh*, *kalar* (*kalr*), etc., though these terms are employed occasionally to denote the presence of common salt, just as *khári* usually indicates a soil containing the sulphate. But it may be here remarked that the earlier investigators of *úsar* lands speak of the sulphate as being the most abundant constituent. Hence apparently Yule and Burnell (*Hobson-Jobson*, *Gloss. of Anglo-Ind. Words*) defines *réh* as an efflorescent sulphate of soda mixed with chloride and occasionally carbonate. On the other hand, Voelcker advanced what is to-day the correct view (*Improv. Ind. Agri.*, 37) when he said of *réh*, "The salts are principally impure carbonate of soda, but sulphate of soda also occurs largely and with them are found common salt and salts of lime and magnesia." An efflorescence of the nitrates of potash or soda would oftener be viewed as of value rather than of danger.

Soil-impregnation.
Names.
Composition.

Réh frequently occurs in such abundance as to give origin to large tracts of desert—and constantly increasing tracts—the surface being literally encrusted with a white, snow-like deposit (hence the name *réh* or *réj* = shining)—or the salt may be invisible and only present to an extent sufficient to greatly lower fertility, or while still hardly visible, may yet render the soil more or less sterile for at least half the year. In passing it may be added that fuller's-earth is a hydrous silicate of alumina, but is often called, though incorrectly, *sajji-matti*: it contains no soda.

Sterility of Soil.

Formation of Usar.—The opinions advanced regarding alkali deposits vary in consequence of what might be called professional bias. Apparently the earliest mention of such deposits is made by Sleeman. His theory is in essentials not far

Formation of Usar.

Canal Influence.
Defective Drainage.
Medlicott's Opinions.
Percentage of Carbonate in Fertile Soils.
Special Crops.
Healthy Circulation.
Permeation of Water.
Conditions that favour *Réh* Formation.
Kankar.

from being in accordance with modern views. It is certainly strange that Royle (*Prod. Res. Ind.*, 1840–75) makes no mention of the phenomenon of *réh* efflorescence. He remarks that Dr. Helenus Scott had sent from Bombay to England a sample of a "mineral alkali" as a substitute for barilla, and so closes his account. He was for some time resident in Saharanpur, and if the *úsar* tracts existed as they do to-day, it is curious that he should not have mentioned them. In 1864 was published (*Select. Rec. Gov. Ind.*, No. xlii.) a correspondence which deals with the deterioration of village lands lying along the W. Jumna Canal and contends that the canal was not responsible for the existence of injurious salts, but that defective drainage in connection with it had led to the accumulation of salt to such an extent as to render cultivation impossible. The inquiry had no practical result. In 1876, however, a committee was appointed to investigate the matter in consequence of a planter's complaint that his land had been spoilt by the mismanagement of canal irrigation. This was the Réh Committee of 1877, of which Mr. H. B. Medlicott was a member. Medlicott (at one time Director of the Geological Survey) began the study of this subject early in the 'sixties. As a member of the committee, he wrote a masterly report which may be said to contain all we know regarding the formation and movement of the soluble alkali salts within the soil. These, he tells us, are formed from normal soil-materials by the disintegration caused through the growth of plants and tillage. The silicates are broken up by the action of heat, air, water and carbonic acid, etc., with the manifestation of the various alkalis that are formed or reformed during the several changes that ensue. During the production and maintenance of fertile soils, carbonate of soda, for example, is as a rule a transitional compound and is destroyed with the elaboration of other and more essential constituents, especially in the presence of lime. In most fertile soils the percentage of that carbonate is accordingly remarkably low. In fact the total of soluble soda salts in good soils rarely exceeds 0·1, of which ordinarily one-half may be the carbonate. Crops, more especially cereals, may however be grown on soils that contain 0·1 per cent. of carbonate of soda, and 0·2 per cent. is sufficient to cause serious injury if it be not found fatal, except perhaps to the so-called saltworts or saltbush—plants that are actually found to luxuriate on briny soils or littoral swamps. At times, however, as already observed, the surface soil may become encrusted with soluble salts, as much as 2 to 6 per cent. or much more being often present. Normally these soluble alkalis are carried by the rain-water or irrigation to the subsoil, and a certain percentage are detained mechanically, the surplus being carried away by the drainage. Where subsoil drainage is defective, as a purely local and temporary measure surface wash may prove beneficial. For this purpose trenches or pits are dug, and the surface water dissolves the salts and carries these to the trenches, thereby leaving the higher ground less charged with alkali. But the evil consequence of even a temporary cessation of soil-permeation may be exaggerated under certain conditions such as (1) recurring periods of hot, parching winds; (2) absence of soil-covering (*i.e.* wild herbage or crops and trees); and (3) defective tillage (*i.e.* superficial ploughing or puddling during flood). These are the very conditions that produce *réh* efflorescence, aided by (*a*) the chemical nature of the original soil-materials; (*b*) the physical attributes (or texture, as it has been called) of the soil (*i.e.* abundance of clay and the conditions of the clay; abundance of sand or of lime, etc.); and (*c*) the accidental or irregular distribution of (*a*) and (*b*) brought about through countless ages of water action, both during the formation of the alluvial plains and subsequently. For particulars regarding the association of concretionary lime (*kankar*) with *réh*, the reader is referred to **Lime**, p. 711.

Capillary Action.
Californian Experiments and Results.

Diffusion and Capillary Action.—Dr. Center (then Chemical Examiner to the Panjáb Government) wrote in 1880 a most valuable *Note on Réh or Alkali Soils and Saline Well Waters*, in which he dealt in great detail with the movement of these salts within the soil and their temporary accumulation on the surface. They may be spoken of as first diffused, then carried to the surface by capillary action. Hilgard and Loughbridge, in connection with the Californian Experimental Station of Tulare, have carried these investigations to their final issue by tracing, in every detail, the actual movement of the salts in sterile soils, before and after irrigation, and have exhibited their results graphically, in direct correspondence with a most critical analysis of practically every inch of soil to a depth of 4 feet. They have also demonstrated beyond dispute that this movement to and from the surface is directly a result of imperfect drainage in conjunction with severe surface evaporation.

Use of Lime Salts.

Farm-yard Manure.

Green Manure.

American Reclamation Methods.

Gypsum.

Manuring and Tillage.—Dr. Brown (then Chemical Examiner to the Panjáb) investigated the use of lime salts as manures to be employed in the treatment of *réh* soils, and his views were published by Mr. Baden Powell (*Pb. Prod.*, 1868, 149) as follows:—" When the deleterious sulphates and carbonates are mixed with *any soluble salt of lime*, such as the nitrate of lime, decomposition occurs and nitrate of soda is formed while carbonate and sulphate of lime are produced. Carbonate of lime is insoluble in pure water and has no power of injuring plants, while nitrate of soda and sulphate of lime are beneficial in supplying them with nitrogen, the former by direct decomposition of its acid and the latter by absorbing ammonia from the air. Nitrate of lime is formed whenever organic matter decomposes in contact with carbonate of lime." Some years later Brown advocated the use of farm-yard manure and green manuring with such plants as ***Calotropis gigantea*** on the ground of their supplying the nitrogen which, in combination with the lime (naturally present in all *kalr* soils), would tend to reduce the carbonate of soda to a harmless condition. Center wrote a long and highly instructive report on the chemistry of the *úsar* soils, and confirmed in the most striking way Brown's recommendations for lime nitrate. He also gave an account of the operations in the Utah Basin and other parts of America, where heavy nitrating manures were employed as a remedial measure for alkali soils. Later on the sulphate of lime (**Gypsum**, see pp. 716–7) gained a well-deserved reputation as a chemical substance that might be employed with great advantage in the neutralisation of the sodium carbonate in *úsar* soils whenever that salt predominates. Where *réh* consists chiefly of sulphate of soda, gypsum would very possibly do harm rather than good.

Extensive Chemical Investigations.

Sodium Carbonate.

Physical Property of Soils.

Value of Gypsum.

Principles Involved.

'Hard pan."

Initial Action.

Tree Cultivation.

The next most important step, therefore, in the study of the chemical treatment of úsar soils may be said to be Leather's various papers that have appeared in *The Agricultural Ledger*. These give extensive analyses of soils, waters, etc., from the entire alkali area of India. They contain the results of practical experiments to test the amount of soluble alkali salts that may exist in soils before these become poisonous to vegetation. They indicate the plants that first show signs of succumbing to the influence of these salts, and the amount of each salt that proves fatal. By special pot cultures of various plants, Leather proved that sodium carbonate is (as has always been upheld) infinitely more injurious to plant life than are any of the other soda salts. But perhaps the most instructive part of his researches was the demonstration of the physical property (alluded to by Romanis, Wallace and others) possessed by carbonate of soda, which greatly augments its injurious chemical influence on plants. While filtering soils in order to obtain their soluble salts, Leather observed that certain soils could practically not be filtered. A little muddy water percolated through at first, but very soon the surface of the filter-cloth became coated with a perfectly impenetrable layer, and further filtration was then impossible. The soils that manifested this peculiarity were those most highly charged with carbonate of soda. To remedy this defect he experimented with gypsum and soon ascertained that its well-known merit as a chemical manure in the reclamation of *úsar* soils rested as much on the destruction of the impervious deposit as in the reduction of the " white " to the " black alkali." It would thus appear that should climatic and soil conditions exist sufficient to give origin to a *réh* efflorescence containing carbonate of soda, there must sooner or later be produced (at a certain position or depth) an impenetrable layer through which surface percolation of water would be impossible. This waterproof layer may not be sufficiently developed to be visible to the naked eye as a " hard pan," but if carried near to the surface it will give origin to a crust of salt. A change in the physical condition of the soil is accordingly quite as urgent a necessity as in its actual chemical composition. It may thus be inferred that subsoil drainage, below an impervious layer, would be next to useless unless the soil be chemically treated with some of the soluble lime salts, or be penetrated for tree cultivation by deep pits filled in with fresh soil. It would indeed seem probable that the surface vegetation that has been reported as accompanying successful tree cultivation, may be due very largely to the pits dug for trees having acted as openings through the impenetrable layer by which the soluble salts of the surface have been washed into the natural drainage.

Is Complete Neutralisation Essential ?

By way of concluding these observations regarding gypsum, it may be suggested that it is not necessary to assume that the exact amount of that salt which would be required chemically to neutralise the ascertained weight of carbonate present need be given as a manure before beneficial results may be

Important Factors.

Soil-washing.

looked for. Gypsum is useless without water and unnecessary where the carbonate is absent. But its action is largely physical in allowing soil percolation. Unless, therefore, a free subsoil natural drainage exists it must be provided before any heavy expenditure is incurred for gypsum as a manure. At the same time land treated with gypsum should be planted with saltworts or other plants that have been found hitherto impossible of cultivation. If these can now be raised on the soil, it may be inferred that provision has been thereby made for the injurious salts being washed out of the soil, and that, too, long before it has been necessary to add, from a financial point of view, a prohibitive amount of gypsum.

American Results.

American and Indian Experience.

Reclamation easy.

American Results.—This leads, therefore, very naturally to a brief reference to the admirable investigations and practical results that have been attained by Hilgard and Loughridge in the reclamation of alkali wastes in California (*Agri. Ledg.*, 1896, No. 1). These officers performed an extensive series of experiments and analyses, with the result that they arrived emphatically at the same conclusions as our Indian experts had done many years previously, namely, regarding the history of the formation of the alkali salts, their movements in the soil, and lastly their treatment with drainage, chemical manures, and selected or special crops. The difference between American and Indian experience in this matter may therefore be said to be that in the former country the scientific experts were at the same time the administrative staff who had to deal with the alkali wastes. Their observations were not treated as scientific theories, but were at once put to practical test, with this result, that alkali wastes are in America not only regarded as comparatively easy of reclamation but have actually been largely turned into some of the most profitable of lands.

Soil protection.

Plants that grow on Saline Soils.

Helpful Vegetation.—Medlicott urged that to protect the soil from the excessive heat of the summer months and consequent injurious capillary efflorescence, it was most important to alleviate the serious Indian defect, viz. the almost total absence of arborescent vegetation from the agricultural tracts of the country. But there is an aspect of vegetation that seems to have entirely escaped Medlicott's observation, namely, the employment of certain plants as direct agents in reclamation. It is well known that many plants not only can survive on soils that contain a proportion of alkali that would be fatal to others, but that they actually luxuriate under such soil conditions. Of this nature may be mentioned the Saltworts (see under **Barilla**, pp. 113–4). Long, therefore, before reclamation could be carried to the extent of admitting of ordinary crops or even of arborescent cultivation, the soil might be protected from the sun by saltworts, and have at the same time large amounts of its poisonous salts removed by the temporary cultivation of such plants.

Protection from Cattle.

Soil-garment.

Invading Grasses.

Fodder a Necessity.

Indigenous Saltworts.

This subject has not, however, been entirely neglected in India. It was believed that were alkali lands protected from cattle for a number of years, or even annually from the close of the rains through the hot months, the plants produced during the rains might be encouraged to survive and even others, including trees, gradually to invade such protected localities, until in a few years' time the growth of a soil garment might ultimately prevent efflorescence. Such experiments have actually been conducted, and with considerable success. The plant found first to invade the protected barren lands was the grass known as *khár úsara* (***Sporobolus arabicus***), which from its vernacular name may be inferred to be a salt-loving species. ***Sporobolus coromandelianus*** (*bhurburoi*) also springs up readily enough, but only during the rains. It, however, affords useful fodder, although it does not protect the land from the summer's heat. After partial reclamation the *dáb* (***Eragrostis cynosuroides***), the *dúb* (***Cynodon dactylon***), the *bat* (***Diplachne fusca***), the *janewa* (***Andropogon annulatus***) and several other species readily appear. Since fodder is of necessity a pressing need in all parched lands, it is valuable to know the Indian grasses that should be first resorted to in reclamation operations, but it is unfortunate that the true saltworts have not hitherto been seriously investigated in India since they would appear more desirable preparatory plants to any of the grasses named. We read of a few desultory experiments having been put forth to acclimatise the Australian Saltbush, but it does not seem to have occurred to any of our Indian agricultural authorities that this country possesses perhaps a richer and more varied assortment of indigenous saltworts than is to be found in any other. In the Panjáb and elsewhere a few of these have been (one might almost say) systematically cultivated for the production of barilla, but not one of them, so far as I can discover, has been seriously investigated as a preparatory crop in *úsar* reclamation. Mollison makes no mention of the Indian saltworts, though he refers to the Australian Saltbush.

Useful Trees.

Immediate Returns.

There is a wide range between the saltworts that may be grown on soils highly impregnated with alkalis and the plants that refuse to grow on soils that contain a particle above what might be called normal soil-supply. But partiality or impartiality is not governed by botanical considerations, since within one and the same natural order of plants both dispositions may be met with. It would thus seem highly necessary that lists of plants should be framed, after searching tests have been performed indicative of the selection of saltworts, trees and useful crops that might be grown progressively on land under reclamation. ***Acacia arabica, Butea frondosa*** and ***Dalbergia Sissoo*** have been spoken of as useful trees, but these belong to the LEGUMINOSÆ, a family which shows a stronger aversion to saline salts than almost any other that might be mentioned. They may, however, be good, but are they the best that could be chosen ? If the most convenient and serviceable, at what stage should they be planted, and with what other plants preceded, associated or followed ? These are questions of the greatest possible moment to India, but to which at present no satisfactory answer can be given. The greatest fault, however, with all Indian endeavours, such as they have been, at reclamation and reforestation, has been the impecunious craving and short-sighted policy of desiring immediate returns.

Industrial Uses.

Industrial Uses of Soda.—Incidentally this subject has already been dealt with. Throughout India soda soils are washed and more or less pure carbonate obtained. At one time a fairly large trade was done in this way in South India (Salem, Mysore, etc.) and expectations of a considerable development entertained. Licenses were granted in Bihár, the United Provinces and elsewhere for the manufacture of *sajji* and *rasi* (two qualities of carbonate of soda) from saline earths. The object in licensing the industry is to protect the revenue, since from the factories concerned fairly large quantities of common salt are obtained, especially at the factories and refineries for the production of saltpetre. (For method of manufacture, see **Glauber's Salt**, p. 56.)

Lake Supplies.

Different Qualities.

Carbonate of soda of a very pure kind is regularly prepared at the Lonar Lake at Berár. Ball says (*Man. Econ. Geol. Ind.*, 494), " Blocks of mixed salts are obtained by divers in certain parts of the lake, but the waters of the lake, on evaporation, deposit salts among which the principal is carbonate of soda. . . . The local names for these products are *dalla*, which consists of a close collection of acicular crystals, between two compact surfaces ; *kuppal*, a thin kind of *dalla*, principally of red colour ; *papadi* or *papri*, a white saline froth."

Glass-making.

Whether obtained from soil efflorescence or from salt lakes by treatment with sulphuric acid, the mixed salts (especially where the greater proportion is already the sulphate) may be reduced to a salt-cake (similar to that obtained in the first stage in the Le Blanc process of manufacture), and by calcining with lime and coal that may be converted into soda-ash. At Awah, in the United Provinces, an attempt was made, in 1880, to utilise the *réh* efflorescence in the manufacture of glass and glass-beads. A complete set of tools was imported from Venice, but the following, among other conclusions, appear to have been arrived at regarding these and all such experiments at utilising the alkali deposits in glass-making :

(*a*) The impurity of the alkali prevents the formation of good quality of colourless glass.

(*b*) It is, therefore, necessary to organise chemical works to produce pure alkali.

(*c*) Good beads could be made, but doubtfully at a lower price than they can be imported.

(*d*) Improvement of glass manufacture in India would depend on the work being done on a large scale with skilled supervision.

Native Industries.

Dyeing.

Bleaching.

Tobacco Adulteration.

Wherever soda efflorescence is at all abundant, the Native industry of glass-making (such as it is) is more or less prevalent, especially that of glass bangles. But *réh* and *sajji* are put to an infinite variety of other uses by the Natives. They are employed for dissolving crude lac and *kamela*, preparatory to dyeing silk, also for extracting the crimson dye from safflower in cotton dyeing. They are used for bleaching silk, cotton and wool. *Sajji* is employed, in Farukhábád, in making country paper from hemp. Both salts, in conjunction with shell-lime, enter into the composition of country soap. White *réh* sprinkled into boiling cane-juice is employed to neutralise the organic acids in the manufacture of sugar, a process very similar to that of the use of lime (p. 712), barium carbonate (p. 57), or strontium carbonate (p. 58) in Europe. *Réh* is an adulterant of tobacco, and is added to

Ceramic Art.

increase the weight. In Native medicine these salts are supposed to be digestive and hepatic. The effort to utilise in the potter's art the peculiar clays that are in association with carbonate of soda has not as yet received the consideration that it deserves, although the ceramic art of India has been the subject of special study. As a historic fact, that has escaped the attention of most writers on this subject, it may be said that some 60 years ago Sir William O'Shaughnessy submitted to the Government of India the results of an inquiry which included extensive trials of Bengal clays, such as Kolgong *khari*, Saban *miti*, Rotas clays, Moulmein clays, Singapore clays, etc., as also numerous experiments in glazing the pottery turned out. [*Cf. Beng. Dispen.*, app., 700–17.]

Black Salt.

6. **Black Salt** (*kála-nun*, *kála-nimak*) is an article of some importance in the local markets of India. It is prepared in Upper India, chiefly at Bhiwáni in Hissár.

Medicine.

Common salt is heated with the chebulic and emblic myrobalans together with *sají*, until a sort of fusion takes place. The article so manufactured is used as a MEDICINE. Dr. Warth favours me with a note on this subject from which he would appear to regard sodium sulphate as an indispensable ingredient. He writes: "I have produced perfect specimens by fusing a mixture of pure common salt with sodium sulphate, a little sodium carbonate and organic matter represented by sugar. According as the proportion of anhydrous sodium sulphate varied from 1 to 3 per cent., a more or less strongly medicinal salt was produced varying from pink to a decided vermilion colour, whilst as much as 15 per cent. of the sulphate yielded a very dark purple-coloured salt. All these had the characteristic sulphuretted-hydrogen smell, and gave the same chemical reactions as the Native-made product. The jungle fruits which they add can have no special influence on the salt because they are completely carbonised and serve only as reducing agents for the sulphate to sulphide, the characteristic material of the prepared medicinal (or black) salt."

Phuli.

Flavouring for Tea.

7. **Phuli.**—This is believed to be a form of carbonate of soda.

It is imported into Leh from Changthan, Rupshu and Nubra in Ladákh. It is said to be extensively used for mixing with tea to bring out its strength. It is exported to Kashmir and Kúllu and into Lower India. The Bhotyas are said to use it for washing clothes and for dyeing wool. The average imports appear to be from 50 to 120 tons, and the average cost about Rs. 6–4–0 per maund.

8. **Barilla** or **Sajji-khar** (see **Barilla** and The Indian Saltworts, pp. 112–4).

9. **Borax** or **Sodium bi-borate** (see **Borax**, p. 171).

Caustic Soda.

Imported.

Paper Mills.

10. **Caustic Soda** (= *kshará* in Sanskrit).—So much space having been devoted to carbonate of soda and a further article to sodium bi-borate, the present salt must be disposed of in the briefest possible manner. At the present day it may be said that India's supply comes entirely from foreign countries. One of the Indian paper mills is believed, however, to have attempted the preparation of its own supplies from the *réh* salts found in the neighbourhood, but it is not known whether its endeavours in that direction were successful.

Decomposition of Common Salt.

The greatest possible interest has been aroused in Europe and America through the discovery of a method of direct decomposition of common salt into caustic soda and chlorine gas by means of electricity. With regard to Electro-Chemistry the reader might consult *The Mineral Industry* (New York, 1900, 763–72).

Sulphuric Acid.

The Indian press have hailed the discovery of the direct decomposition of salt as bringing a cheap supply of alkali to the doors of our Indian soap-works, paper-works, etc., owing to the possession of a limitless supply of sodium chloride. The great recommendation to India of this new method lies in the fact that sulphuric acid is not required. Without sulphuric acid Le Blanc's manufacture of soda-ash could not be brought to bear on our supplies of common salt or of *réh* efflorescence—hence in all probability the backwardness of India in chemical enterprise.

11. **Sodium Chloride** (see **Salt**, pp. 963–71).

Glauber's Salt.

12. **Sodium Sulphate, or Glauber's Salt.**—This is generally known in India under the name ***kharí*** or ***kharinun***, and as already ex-

plained (p. 51 *et seq.*) it is met with as one of the efflorescent salts that constitute *réh*. It has been shown (p. 50) that the chief use of this salt might be regarded as in the preparation of carbonate of soda. Its production is at all events the first stage in the Le Blanc process of soda manufacture, and where met with at all abundantly as a surface efflorescence it might be viewed as the first stage accomplished without the expense of sulphuric acid having been incurred.

First Stage—Carbonate Manufacture.

This salt is in India derived from *réh* efflorescence, either by solar evaporation (*abi*) or by artificial heat (*jaria*), and by a method very similar to that pursued with crude saltpetre. The quality of the earth collected is of course different in each case, but the nature of the filters, boilers and pans employed is the same; and for evaporation and condensation of the brine, boilers and *chunam* pans are both used, the former in Bihár and the latter in the United Provinces of Agra and Oudh, where prolonged dry, hot weather may be more confidently reckoned on than in Bihár.

Patna-khari.

Preservative for Hides.

Cattle Medicine

Industrial Uses.—*Patna-khari* (as the *khari* produced in Bihár is called) is used chiefly for preserving hides, and also as a cathartic for cattle; it sells at from 8 to 12 annas a maund, and contains very little sodic chloride. *Khari* produced up-country, by solar evaporation, is also much employed as a cathartic for cattle. It contains, however, a considerable percentage of common salt (20 to 30 and sometimes even more); it realises from 12 annas to one rupee per maund. Glauber's Salt may be said to be better suited than common salt for the curing of hides, owing to the tendency of the latter to absorb water and soften the hides. The *khari* (or *chamra-khari*) of Bihár being as a rule purer than that of the United Provinces, is accordingly in greater demand. Buchanan-Hamilton in 1809 drew attention to this circumstance by his having pointed out that the *patna-khari* was the best procurable in India. According to Dutt (*Mat. Med. Hind.*, 1900, 90) it was known to the recent Sanskrit writers under the name of *kshári lávana*, and was used medicinally in combination with other saline substances. As manufactured in India it is an impure salt.

Alkaline Earths.

ALKALINE EARTHS. Having now discussed the true alkalis and their salts with as much detail as the available space will admit, it becomes necessary to record the chief facts known regarding the Alkaline Earths and their salts as met with in India.

Baryta.

13. **Barium and Baryta;** Ball, *Man. Econ. Geol., Ind.*, 473–4. The oxide of this metal (baryta) is an extremely caustic, poisonous and strongly alkaline substance that forms a hydrate with water.

Carbonate.

Used in Pottery.

14. **Barium Carbonate.**—This is imported into India to a very limited extent. It is highly poisonous. In Europe it is employed as an ingredient in certain forms of pottery and glassware, and is the basis of certain delicate colours. In France it is used in the defecation of beet-root sugar in place of lime. [*Cf. Min. Indust.*, 1900, 53–4.]

Nitrate.

Baryta Green.

15. **Barium Nitrate.**—This is obtained by decomposing the carbonate by means of nitric acid. It is the chief salt employed in pyrotechny for the production of green fires. It is also the tinctorial principle in BARYTA GREEN—a pigment of some value. Recently barium nitrate has been substituted for saltpetre in the preparation of certain explosives.

Sulphite.

Barytes.

16. **Barium Sulphate.**—This is the most important of the barium salts and is known as BARITES (BARYTES) or HEAVY-SPAR. It is found in mineral lodes and usually constitutes a distinct portion of the gangue there present. In the Karnúl District, Madras, it occurs along with galena, within the veins of quartz. Large quantities also occur with quartz, forming a network of veins, as for example near Alangayam, Salem district (Holland, *Rec. Geol. Surv. Ind.*, 1897, xxx., pt. iv.) If ever worked, large supplies could be obtained from that locality. So, in the same way, barytes exists in the Central Provinces in association with copper such as at Jabbalpur and in the Rewá State. In Rajputana barytes has been reported by Dr. Irvine as occurring at the lead mines of Taragarh in Ajmir. In the Panjáb it has also been found in association with galena at Subáthu in the Simla district. While it would thus appear that the Indian sources of this alkaline earth have not been worked, barium sulphate is nevertheless available in every bazár and seems to be very largely sold as "white lead," or in adultera-

Adulteration with White Lead.

tion with that substance. The reader will find an example of the extent to which this sulphate is employed in India by consulting the account given of the Afridi Wax-cloth industry under ***Carthamus Oxyacantha*** (pp. 276, 282). Used by Paper-makers. Barytes is also used by the paper-makers, and to a limited extent as a cheap substitute for barium nitrate in certain forms of fireworks.

17. **Calcium and its Salts** (see **Lime**, pp. 709–19).

Strontium. 18. **Strontium and Strontia.**—The oxide strontia does not exist in nature, but it may be produced by burning either the carbonate or the sulphate.

Celestite. Celestite, the sulphate of strontium, has been reported as met with in two localities in India, viz. in the Kirthar limestones of Sind and in the red clays of Surdag in the Salt Range. Sugar Refineries: Strontianite. In the sugar refineries of the Continent of Europe the native carbonate (*Strontianite*) was formerly used in place of lime (*Journ. Soc. Chem. Indust.*, Nov. 1901, 1092). But the metal is chiefly known in India in the form of the imported nitrate which is largely employed in the preparation of red-coloured flames in fireworks.

ALKALOIDS (see Aconitum, Cinchona, Papaver, etc.).

D.E.P., i., 168 75., **ALLIUM,** *Linn.*: *Fl. Br. Ind.*, vi., 337–45; Liliaceæ. A genus of bulbous herbs which embraces about 250 species, all indigenous to the temperate regions. In addition to the onion and the garlic (which are the most important species), the shallot and the leek (***A. ascalonicum***, *Linn.*, and ***A. Ampeloprasum***, *Linn.*) are also cultivated in India, the latter being the *parú* of Bengal and the *kiráth* or *kirás* of Arabia. In Western India, according to Woodrow, leeks succeed best at altitudes of 2,000 feet.

Onion. **A. Cepa,** *Linn.*; Duthie, *Field and Garden Crops*, iii., 5, pl. lxv.; Mollison, *Textbook Ind. Agri.*, iii., 211.

The Onion is extensively cultivated in India, chiefly near large towns, and is known as *piyaz, pálándu, kanda, vella-vengáyam, vullu-gadalu*, etc. There are two forms, a small silvery and a large red or yellow. Patna and Bombay (Jangira) are famous for their onions, and, speaking generally, the onions from the Best Quality. northern provinces are the largest and best. The size and quality would seem Transplanting. to be improved by transplantation, which is also a preventive against disease from fungi and insects. Seeds will not keep in India for more than one season, hence selected bulbs are planted for seed purposes at the beginning of the cold season. After careful preparation the seed-bed should be sown about September and the seedlings transplanted in November or early in December. The crop may be lifted from March to May. In two test cases mentioned by Mollison the yield was about 35,000 lb. to the acre. Onions are extensively eaten in India by Muhammadans, much less frequently by the Hindus; they are occasionally given to milch cows and buffaloes. There would appear to be a considerable export trade in the bulbs from Bombay to Zanzibar, Japan, etc. [*Cf. Ain-i-Akbari*, 1590, 63; Sen, *Rept. Agri. Stat., Dacca*, 1899, 25, 38, app. vi.–xii.; *Imp. Dept. Agri., West Ind.*, Pamphl. Nos. 16–21.]

Garlic. **A. sativum,** *Linn.*: Duthie, *l.c.* 34, pl. lxvi.; Mollison, *l.c.* 214. The Garlic, *lasan, rasún, belloli, thúm, sir, vallai-púndu*, etc., is cultivated throughout India, the cloves (or small bulbs) being planted out in October and the crop gathered in the beginning of the hot weather. As showing the extent to which the seasons of production vary, it is reported of Coimbatore district, South India, that planting commences in May–June and harvesting in September, being followed by a tobacco-crop, or if planted in December and gathered in March, it is followed by *cholam*. According to Mollison, a good crop will yield 8,000 to 10,000 Food. lb. per acre and be worth Rs. 250 to the cultivator. As a Food, garlic is almost universally used in curries by the Natives, who also eat the bulbs almost daily. Medicine. In Medicine it is regarded as a stimulant, expectorant, tonic, and employed as a remedy in bronchial affections and as an application for deafness. Dymock Domestic. (*Pharmacog. Ind.*, iii., 489) says that after intense fatigue a clove of garlic slowly Cement. chewed and swallowed acts as a very powerful restorative. The freshly expressed juice makes an excellent Cement for glass-ware. The imported Muscat-garlic is much used for pickling. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 147.]

D.E.P,
i., 179-90.
Aloes.

ALOE, *Linn.; Fl. Br. Ind.*, vi., 264; *Pharmacog. Ind.*, iii., 467-76; *Rept. Cent. Indig. Drugs Comm.*, i., 116, 126, 149, 158; HÆMODORACEÆ. Several species of ALOE and diverse methods of extracting, drying and preserving the juice result in the supply of the different known qualities of this drug. The following species may be specially mentioned as affording the major portions of the aloes of Indian commerce:—

Jaferabad.

A. abyssinica, *Lam.;* Baker, *Journ. Linn. Soc.*, xviii., 174. Jaferabad and possibly also the bulk of the Moka aloes imported from the Red Sea coast. This is prepared at the town of Jaferabad in Kathiawar by persons supposed to be of African descent. It is sold in the form of flat circular cakes almost black in colour, has a glassy fracture and yields a yellowish powder having a strong aloetic aroma. This, as also the imported Moka quality, constitutes the aloes most in demand in India.

Socotrine.

A. Perryi, *Baker, Bot. Mag.*, 6596. This is the Socotrine Aloes, and possibly also the Zanzibar Aloes of commerce, of which a fair amount is imported into Bombay, and after being assorted is re-exported again to Europe. [*Cf.* Mandelslo, *Travels*, 1639, 15.]

Barbados.

A. vera, *Linn.;* the Common or Barbados Aloes or Curaçao Aloes. Several forms of this species have become completely naturalised in India, and that too from the hot, dry outer valleys of the N.W. Himalaya throughout the central tableland to Cape Comorin.

Indian Names.

Both the aloe plant and aloe drug have Sanskrit and vernacular names attributed to them that would seem fairly ancient. The following may be specially quoted: For the *Plant:—ghi-kunvár, ghirta-kunvár, kumári, kora-kánda, kuvára, kalabandu, lola-sara*, etc. For the *Drug:—ilva, eilya, elio, yalva, mo-shabbar, musumbra, kalabol*, etc., etc. Sir William Jones calls it *taruni, saha, cúmári* (*As. Res.*, iv., 272).

Early Mention.

Most scientific writers are agreed that although the aloe has been completely naturalised in India for a very long time it is not originally a native of the country. Of late, attempts have been made with comparative success to show that some at least of the species might provide an efficient substitute for the imported drug. Indian aloes seem first to have been mentioned by Garcia de Orta (1563, *Coll.*, ii.) as prepared particularly in Cambay and Bengal. He adds that though Pliny and Dioscorides refer to the Indian aloes as the best, they were referring unconsciously to the re-export of the Socotrine product. *Paulus Ægineta* (Adams, transl., iii., 34) reviews the information possessed by the early Greeks, Romans and Arabians, and might be consulted. The early Indian travellers such as Linschoten, Tavernier, Hove, etc., afford useful particulars, but greater details may be learned from Ainslie, Royle, Warring, etc. Rumphius (*Herb. Amb.*, 1750, v., 272) mentions the use of aloes on the Coromandel Coast in the preparation of cement. [*Cf.* Acosta, *Tract. de las Drogas*, 1578, 191-211; Ligon, *Hist. Barbados*, 1657, 98; Rheede, *Hort. Mal.*, xi., t. 3; Kanny Lall Dey, *Indig. Drugs. Ind.*, 19; *Taleef Shereef* (Playfair, transl.), 1833, 138; Tschirch, *Schweiz. Wochenschrift für Chem. und Pharm.*, 1902, No. 23 (attributes the aloes of the Cape to *A. ferox*); Johannes Klaveness, *Studien Natal Uganda-Aloe*, 1901; White and Humphrey, *Pharmacop.*, 1901, 51-2; Ponder and Hooper, *Mat. Med.*; Bens, *Southern Arabia*, 1900, 381.]

Cement.

Trade.

The Indian TRADE in aloes is not a very large one. The total imports come usually to something like 600 cwt. valued at a little under Rs. 20,000 (501 cwt., valued at Rs. 7,994 in 1906-7), a quotation that would seem to be about one-third less than that of 20 years ago. The total exports (including re-exports) would appear to average very nearly the same in quantity and value as the imports. The Indian foreign supply, drawn mainly from Africa and Arabia, and the exports of Indian-grown aloes go mainly from Bombay and Madras. In fact, the most striking modern feature seems to be the growth of an export from Madras to the Straits Settlements. The re-exports (foreign aloes exported) are made almost exclusively from Bombay and go mainly to the United Kingdom, the next largest demand being made by the Straits Settlements.

Imports and Exports.

D.E.P., i., 191-7.

ALPINIA, *Linn.: Fl. Br. Ind.*, vi., 252; SCITAMINEÆ. A genus that contains some 40 species inhabiting the tropical and subtropical regions of Asia, Australia, and the Pacific Islands.

Galangal.

The two most important species are ***A. Galanga***, *Willd.*, and ***A. officinarum***, *Hance*, which are considered separately below. ***A. Allughas***, *Roxb.*—*taro* or *tarúko*—a native of Bengal, Assam, Burma, Ceylon and the Konkan, has an aromatic rhizome which is used by the natives MEDICINALLY. It has been recently stated that the leaves and stem yield a FIBRE which might possibly be useful in paper-making, owing to its exceeding abundance. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1904-5, 28.] ***A. khulanjan***, a supposed new species described by the late Dr. Moodeen Sheriff in 1869 [*cf. D.E.P.*, i., 194], is believed to be the same as ***A. officinarum***, but owing to the continued uncertainty the latter species has been kept separate. ***A. Nutans***, *Roxb.*, the Light Galangal, is a native of the Eastern Archipelago, much cultivated in Indian gardens. The rhizome is used in place of the Greater or Java-Galangal, and is sometimes mixed with it or with ginger.

Medicine.
Fibre.

A. Galanga, *Willd.*; the Greater or Java-Galangal, the *barakulinjan*, *motha-kolanjan*, *pera-rattai*, *pera-ratta*, *padagoji*, etc., is found throughout India from the foot of the Himalaya to Ceylon and Burma: distributed to the Malay Islands and widely cultivated.

Medicine.

It is mentioned by Marco Polo (A.D. 1290) as grown in Bengal, and by Varthéma (1510) as found in Cambay. Garcia de Orta (1563) and Linschoten (1598) say that there are two sorts, one Chinese called "Lavandon," the other Javan and there called "Lanquas." The latter, they say, was sown in Indian gardens. The rhizome of both species are mentioned and figured by Clusius (*Hist. Exot. Pl.*, 1605, 211). The rhizome and the fruit (***Galangal cardamom***) are sold in the bazárs, and the former is said to be used in the United Provinces in calico-printing. It seems probable that the Greater Galangal is only used MEDICINALLY as a substitute for the Lesser or Chinese Galangal. [*Cf.* Acosta, *Tract. de las Drogas*, 1578, 58; *Kew Bull.*, 1891-5; 1892, 16-20; 1896, 233; *Pharmaceut. Journ.*, Jan. 31, 1891.]

Medicine.

A. officinarum, *Hance*; the Lesser Galangal, ***Alpinia chinensis*** of chemists, is commonly sold in the bazárs as *kúlinján* or *kolijána*. Also called *chota-pan-ki-jar* or *choti-kulijan*, *shitta-rattai*, *khusro-dáru*, etc.

It is a native of China from whence the rhizome is exported largely to India, and somewhat less than in former days to England. The principal demand for it is in Russia, though it is still an ingredient in certain old-fashioned English MEDICINES. In India it is considered a nervine tonic and an aphrodisiac.

Trade.

It is not possible to distinguish between the Greater and Lesser Galangal in the Indian trade returns, but the collective imports have increased from 2,794 cwt., valued at Rs. 21,525 in 1899-1900, to 5,202 cwt., valued at Rs. 39,731 in 1902-3, though they have since declined to 3,918 cwt. in 1906-7, valued at Rs. 21,375. The collective exports also have fallen from 1,327 cwt., valued at Rs. 12,255, in 1899-1900 to 393 cwt., at Rs. 3,476, in 1902-3. Since then, however, the exports have shown an increase—viz. to 1,245 cwt., valued at Rs. 12,249 in 1905-6. In 1906-7, however, they fell to 614 cwt. and Rs. 6,338. By far the largest increase is in the trade from China (Hongkong)—viz. from 692 cwt. in 1899-1900 to 3,200 cwt. in 1904-5, and 2,104 cwt. in 1906-7.

D.E.P., i., 197-9.
Dita-bark.

ALSTONIA SCHOLARIS, *R. Br.: Fl. Br. Ind.*, iii., 642; Gamble, *Man. Ind. Timbs.*, 483; Cooke, *Fl. Pres. Bomb.*, ii., 132; APOCYNACEÆ. A tall evergreen tree of the moister regions of India, but nowhere very common. It affords the *dita-bark* of commerce, and is known in the vernacular as *chatwan*, *chatiúm*, *lationj*, *satiána*, *pala*, *pala-garuda*, *rukattana*, etc.

Medicine.

The bark is used in MEDICINE as an astringent tonic, anthelmintic, alterative and antiperiodic. It is a remedy in cases of chronic diarrhœa and advanced dysentery, as also of catarrhal fever and stomachic debility. Externally the milky juice is applied to foul ulcers and is also used with oil in earache. *Ditain*, an uncrystallisable substance obtained from the bark, and also a tincture of ***Alstonia***, appear to be useful in cases where quinine produces distressing secondary symptoms. The Report of the Indian Indigenous Drugs Committee (i., 419-38) seems to show that the drug is useful in diarrhœa and dysentery, but

Timber.

that its effect as a febrifuge is not lasting (*Pharmacog. Ind.*, ii., 386). The TIMBER, which is not durable but easily worked, is used for boxes, furniture, scabbards, coffins, etc., for blackboards (dusted with sand) in Burma, whence the name ***scholaris***, and, according to a correspondent of *The Agricultural Bulletin of the Straits and Federated Malay States* (1903, ii., 114), the young wood is employed in Borneo as a substitute for cork in bottle-stoppers (see **Gutta-percha**, p. 627).

D.E.P., i., 200-1; v., 78-80. Storax.

ALTINGIA EXCELSA, *Noronha : Fl. Br. Ind.*, ii., 429; Gamble, *Man. Ind. Timbs.*, 332; Brandis, *Ind. Trees*, 302; HAMAMELIDACEÆ. Burmese storax, *rasamala*, *siláras*, *jutili*, *nantayok*, etc. A lofty deciduous aromatic tree of Assam and Burma, Yunnan, Java, etc.

Resin. Perfume. Medicine.

This, like the closely allied ***Liquidambar orientalis***, *Mill.*, of Asia Minor (the Liquid *Storax*), yields a fragrant balsam, known as *nan-ta-yok* in Burma, which is used in that country as a perfume, incense and medicine. The true *STORAX* (***Styrax Benzoin***) is imported into Bombay, and is used all over India as a MEDICINE both by the Muhammadans and Hindus. The Burmese article to all intents and purposes is identical with the *rasamala* of Java, and is little if at all inferior to the resin of Asia Minor. Hooper (*Agri. Ledg.*, 1904, No. 9) reviews all available information on this subject, and concludes by saying that his chemical investigations confirm those of Prof. A. Tschirch and Dr. L. van Itallie—viz. that while the Burmese storax (like the *rasamala*) differs in some respects from the true article, it might be pushed in trade as a good substitute. [*Cf. Pharmacog. Ind.*, i., 593–8; *Archiv. der Pharm.*, Sept. 1901, 239, 541–7; *Journ. Chem. Soc. Indust.*, xx., 1122; Hooper, *Rept. Labor. Ind. Mus.*, 1900–1, 18; 1904–5, 24–5.]

D.E.P., i., 201-4. Alum.

ALUM and ALUMINIUM-ORE; *Bauxite*, *Laterite*, etc.; Holland, *Rev. Min. Prod. Ind.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., 94; Oldham, *Man. Econ. Geol. Ind.*, 303, 352; Ball, *Man. Econ. Geol. Ind.*, 431–5; *Journ. Soc. Arts*, 1903–4, lii., 145; Brough, *Cantor Lect.* Alum, *phitkari*, *phatkiri*, *sphatikari*, *shib*, *zák*, *patakri*, *kyankchin*, etc., is prepared from alum-shale in several localities of Bihar, Kach and the Panjáb. It is also found, but not worked, in Upper Burma.

Imports.

Alum appears at one time to have been very extensively imported into India from China, and the price on the Calcutta market in 1809–11 is quoted as 3½–6 *sicca* rupees per maund (Milburn, *Or. Comm.*, 1813, ii., 498), but it is curious that there is no hint of any such trade in the E. India Co.'s records, at the beginning of the 17th century, although we learn that it was then an article of extensive trade with Japan, "for they cannot dye with sapanwood without it" (Foster, *E.I.C. Letters*, v., 7). The Indian production is very uncertain, probably not amounting in all to more than 1,000 tons yearly. Kalabagh on the banks of the Indus and Kotkil at the mouth of the Chichali pass, produce about 400 tons annually between them (*Min. Rev.*, 1894–7, etc.). Mr. Holland says that the yield in 1898 was 750 tons, valued at £3,150, but in 1901 it fell to 98 and in 1902 was 112½ tons. No returns for 1903 were available. But the Indian alum is not so white as the imported mineral, being discoloured by impurities. The alum imported into India during the six years 1898–1903 averaged 69,296 cwt., valued at 3 lakhs of rupees. The actual figures for 1906–7 were 72,344 cwt., Rs. 3,19,407. The principal use is as a mordant in DYEING, but it is also employed in MEDICINE, photography, etc., and in the purification of vinegar (see p. 1110).

Mordant in Dyeing. Medicine.

Aluminium.

Recently it has been discovered that many of the rusty-coloured laterite deposits which cover large areas in the Peninsula and Burma are identical with the substance known as *bauxite*, now the chief source of ALUMINIUM. Like the original bauxite of Les Baux, these deposits were originally worked without

Bauxite.
Caustic Soda.
Electric Decomposition.

success as a source of iron. "It is difficult at present to fully estimate the value of this discovery, as a deposit of laterite, which ordinarily would be regarded as small and of little consequence, contains enough alumina in some of the instances examined to completely swamp the market of bauxite, of which the world's total production is at present little more than 110,000 tons a year. Without any disturbance of present prices, the aluminous laterites would hardly pay, at the ordinary rate for first-class bauxites of 21 to 22 shillings a ton, to mine for export to Europe and America, and they must consequently be utilised for the extraction of alumina on the spot, either for export as such, or for the manufacture of aluminium in the country. To prepare the alumina from the bauxite (or laterite) would, according to the most recent processes, require the use of caustic soda, which is not at present made in the country. But one of the latest successful processes for the manufacture of caustic soda involves the separation of chlorine (from which bleaching powder is prepared) by the electrolytic decomposition of dilute brine, and as both caustic soda and bleaching powder are now largely imported for use in paper-making, there would be a market for both, apart from the requirements of alumina manufacture."

Manufactures.
Aluminium Ware.

Aluminium Manufactures. It is impossible to furnish actual statistical returns of the extent to which this metal has been introduced as an Indian industrial material. Mr. Chatterton, Principal of the Madras School of Arts, pioneered the new industry so very successfully that others were induced to engage in the trade and finally the school withdrew in favour of private enterprise, viz. The Indian Aluminium Co. at Madras, which purchased the Govt. Aluminium Dept. in the school. The Company employed 150 persons in 1901 and 356 in 1904. There are three other factories at Madras, but apparently of small importance. The impetus due to Chatterton's success would seem, however, to have given South India a hold on the aluminium trade that she is not likely to forgo. The imports of aluminium-ware must also be very considerable judging from the extent aluminium cooking-pots, water-bottles and other articles of that nature are now met with throughout India. (See **Corundum**, p. 428.)

D.E.P.,
i., 208 16.
Amaranth.

AMARANTUS, *Linn.: Fl. Br. Ind.*, iv., 718–22; De Candolle, *Orig. Cult. Plants*, 100–1; Bretschneider, *Hist. Europ. Bot. Disc. in China*, 179; AMARANTACEÆ.

There may be said to be two or perhaps three distinct groups of amaranths that are of economic value to the people of India. These are the species cultivated in gardens and mainly if not exclusively as POT-HERBS: second the wild species that are eaten as pot-herbs or MEDICINES: and third the forms cultivated in fields and exclusively so as edible GRAINS. The last mentioned are by far the most valuable and hence may be taken up in greater detail than the others. But in passing it may be observed that the Indian species of this genus seem to be sadly wanting careful study and revision. The limitations of scientific and vernacular names here adopted are given tentatively. Of the garden pot-herbs there are many varieties or recognisable races under each botanical species. These may be indicated as follows:—

Section A. Pot-herbs.

Pot-herbs.

1. ***A. Blitum,*** *Linn., var.* ***oleraceus*** *(sp Linn.),* a plant with small obtuse leaves cultivated mainly in sub-montane tracts. The leaves serve as a pot-herb and the seed as a grain (*Rec. Bot. Surv. Ind.*, i., 169). This may be only a form of the following:—

2. ***A. gangeticus,*** *Linn.; Agri. Ledg.*, 1904, No. 6, 63; Duthie and Fuller, *Field and Garden Crops*, iii., 17-8, pl. lxvii.; *lalsag, chaulaiság*, etc. The vernacular names apply equally to the foregoing species. Roxburgh differentiated ***A. gangeticus*** proper from ***oleraceus, polygamus*** and other forms mentioned below as varieties, by the fact that it gave only one crop and was pulled and sent to market with the roots. Some forms, such as ***A. bicolor*** are grown as ornamental plants. Of the many varieties ***lanceolatus*** is used in curries, ***lividus*** as a pot-herb, and ***oleraceus*** *(sp. Roxb)* as a substitute for asparagus. Then there may be mentioned ***polygamus*** *(sp. Roxb, non Linn.)* [*cf.* Long in ***Journ.***

Agri.-Hort. Soc. Ind., 1859, x., 30] and *tristis* (*sirru kirai*) a vigorous plant much esteemed by the Natives.

3. *A. polygamus*, Linn.; *chelu natia*, etc., the smallest Indian species and a weed of gardens throughout India. It is regarded as a very wholesome pot-herb specially suited for convalescents (*Rec. Bot. Surv. Ind.*, ii., 187; *Agri. Ledg.*, *l.c.* 64).

4. *A. spinosus*, Linn.; *Pharmacog. Ind.*, iii., 138. The prickly amaranth, *taduliya*, *kante-math*, etc., a weed of cultivation throughout India. Is used by the poor as a pot-herb, and in medicine is valued for its mucilaginous properties. (*Rec. Bot. Surv. Ind.*, i., 207; *Agri. Ledg.*, *l.c.* 64, 72.)

5. *A. viridis*, Linn.; *choulaie*, *chaulai*, etc., a weed of cotton soils, but apparently nowhere cultivated. The tender tops are eaten (*Rec. Bot. Surv. Ind.*, i., 354; *Agri. Ledg.*, *l.c.* 65.)

Section B. Grains.

Love-lies-bleeding.

A. caudatus, *Linn.*; *Fl. Br. Ind.*, iv., 719; Duthie, *Field and Garden Crops*, iii., 24, pl. lxviiiA.; *A. cruentus*, *Willd.*, in Roxb., *Fl. Ind.*, iii., 610. Love-lies-bleeding; the *kedari chua*, *ramdana*, etc.

Food-grain: *Ramdana.*

This is fairly plentifully cultivated throughout the plains of India as a garden ornamental plant (and to some extent as a pot-herb also) much after the same fashion as its near allies, the Prince's Feather (*A. hypochondriacus*): the Weeping-willow-leaved Amaranth (*A. salicifolius*): and the Cockscomb (*Celosia cristata*)—all great favourites with the Native gardeners. But *A. caudatus* in India takes a further and more directly economic position since it is cultivated by the hill tribes as a regular field crop, on account of its GRAIN, the *ramdana*. The seed is sown in May and June and the grain is harvested in October. In the plains of Northern, Western and Central India it is also occasionally seen as a cold-season crop being grown on the borders of fields. It is chiefly distinguished from the next species by the obtuse tips of the leaves and the long pendulous tails or spikes of the inflorescence.

Anardana.

A. paniculatus, *Linn.*; *Fl. Br. Ind.*, iv., 718; Duthie, *Field and Garden Crops*, iii., 23, pl. lxviii.; *A. frumentaceus*, *Ham.*, in Roxb., *Fl. Ind.*, iii., 609; *A. Anardana*, *Ham.*, in Wall., *Cat.*; and *A. farinaceus*, *Roxb.*, *Herb.* This appears to be the *anardana* of the early writers but is best known as *chúa*, *chuko*, *ganhar*, *mársa*, *báthu*, etc.

Important Food-grain.

Seasons of Sowing and Reaping.

Cultivated on the Himalaya from Kashmir to Sikkim between the altitudes of 3,000 and 10,000 feet; also on the hills of Central and South India and Burma, and on the plains of Northern, Western and Central India, as a cold-season crop. It is one of the most important sources of FOOD with the hill tribes of India, and there are both golden-yellow and bright purple conditions. The former is more frequent and seems therefore to be preferred; most fields, however, contain a few red plants among the yellow. It is an exceedingly ornamental crop; the hillsides, on account of the fields of this plant, become in autumn literally golden-yellow and purple. It is sown in May and June and reaped in October–November, but in the plains it is not ripe until February to March. (Madden, *Edinb. Bot. Soc. Trans.*, 1858, v., 118.)

Food Value.

It is not possible to furnish information as to the total production of this grain. It is grown as a rule for local consumption and is hardly if ever exported. The grain has been analysed by Church (*Food-Grains of Ind.*, 107–9) and the average of three samples gave the nutrient ratio at 1 : 5·3 and the nutrient value 90. It has been estimated that one plant will produce 100,000 grains. Speaking of another sample, which Church attributed to *A. gangeticus*, but which may possibly have been one of the many forms of the present species, he remarks: "The analysis shows that we have in these seeds a food in which the proportions, not merely of albuminoids to total starch *plus* the starch-equivalent of the oil, but also of the oil itself, are very nearly those of an ideal or standard ratio." Visitors to the hills of India are inclined to smile at people who live very largely upon these minute grains, but they might with advantage to themselves use this extremely wholesome article of diet.

D.E.P., i., 216 7. Fossil Resin. **AMBER**; Mason, *Burma and Its People*, 576; also ed. Theobald, i., 15; Ball, *Man. Econ. Geol. Ind.*, 1881, 57; Holland, *Rev. Min. Prod. Ind.*, 1898–1903, 95–7. A FOSSIL RESIN; *kahrub, ambeng, payen*, etc.

This substance to a small extent is still procured from the ancient mines of Upper Burma (in the Hukong Valley), but a fair amount of Baltic amber is regularly imported into India and Burma. Medicine. It is used in Native MEDICINE, being often confused with ambergris, the word amber having been derived therefrom. Industrial Uses. In Europe it is boiled in oil (rape or linseed) until it becomes transparent and ductile, when it is moulded into beads, broaches, mouthpieces for pipes, etc. Certain qualities are extensively made up as varnishes. In Upper Burma Dr. Anderson tells us (*Mandalay to Momien*, 1876, 202) that there were then only a few workers, and that the amber most prized is perfectly clear and of the colour of dark sherry. Amber is much in demand in Burma by the wealthier ladies, who wear cigar ear-holders of this material. Production. Accurate returns for the production in Upper Burma are not available, but an estimate made by the Deputy Commissioner of Myitkyina gives the average annual output at about 51 cwt., valued at about Rs. 5,000. Qualities. The Burmese material differs chemically and physically from the Prussian amber, the chief difference being the absence of succinic acid; it is distinguished by the special name "Burmite." It is harder and tougher than many other amber-like resins, and therefore more fit for carving and turning. [*Cf.* Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 165; *Paulus Ægineta* (Adams, transl.), iii., 129; Marco Polo (ed. Yule), ii., 341; Milburn, *Or. Comm.*, i., 61; Crawford, *Journ. to Ava*, 1834, ii., 206, etc.]

D.E.P., i., 217. Perfume. **AMBERGRIS**; a concretion formed in the intestine of the Sperm-whale (***Physeter macrocephalus***). Source. It is a substance often found floating in the sea on the coasts of India, Africa and Brazil, and the whales are also hunted and killed to procure it. Is met with in the Indian bazárs in the form of special preparations known as *abr-i-amber*, *anber*, or *araba*.

It is a very light substance, highly inflammable, has a peculiar aromatic odour and almost completely volatilised by heat. It is used as a MEDICINE, the supply coming mainly from the Nicobar and other islands in the Indian Ocean. Though not of great value in modern commerce this substance at one time attracted much attention. It was unknown to the Greeks and Romans, but according to *Paulus Ægineta* (Adams, Comment., iii., 425–6) was made known to pharmacy by the Arabs. Marco Polo (*Travels* (ed. Yule), ii., 341–2) and Clusius on Garcia de Orta (in *Hist. Exot. Pl.*, 1605, 147–9), also Ball on Garcia (*Coll.*, iii., in *Proc. Roy. Ir. Acad.*, i. (3rd ser.), 390), Barbosa, etc., all allude to this substance, so that it has been associated with India for several centuries. Francis Pyrard (*Voy. E. Ind., etc.*, 1601 (ed. Hakl. Soc.), i., 229) states that in the Maldives the ambergris (called *gomen*, and when prepared *meuuare*) thrown up on the coast formed part of the King's revenue. Jahangir (*Memoirs* (Price, transl.), 2–3) describes the way in which it was employed to perfume the throne. In Europe some time ago it was used as a flavouring material with food. By Milton it is alluded to as *grisamber* (*Par. Reg.*, ii., 337). [*Cf.* Blanford, *Fa. Br. Ind.* (Mammalia), 571; Ainslie, *Mat. Ind.*, i., 15–7; *Trans. Med. and Phys. Soc. Bomb.*, n.s., i., 149; xii., 172; Madras, *Man. Admin.*, i., 30; Baden Powell, *Pb. Prod.*, i., 190; Hunter, *Imp. Gaz. Nicobar*, x., 297; Birdwood and Foster, *E.I.C. First Letter Book*, 58, 81, 119, 128, 245–6, 258, 299; Foster, *English Factories*, 1618–21 (ed. 1906), 58; *Burma and its People* (ed. Theobald), 1882, i., 445; *Journ. Chem. Indust.*, 1890, ix., 429; etc., etc.]

AMOMUM SUBULATUM, *Roxb.; Fl. Br. Ind.*, vi., 240; Madden, *Edinb. Bot. Soc. Trans.*, 1858, v., 120; King, *Journ. Linn. Soc.*, 1880, xvii., 3; Duthie and Fuller, *Field and Garden Crops*, iii., 35; *Pharmacog. Ind.*, iii., 436; SCITAMINEÆ. The Bengal or Nepal or winged Cardamom, sometimes also called Greater Cardamom, *bari-ilachi, elcho, moté-veldodé, káttu-yelak-káy*, etc. Is most readily obtained in Calcutta but may be had at Bombay, and perhaps in the bazárs of most large towns. A herbaceous plant, native of Nepal.

D.E.P., i., 222-3. Greater Cardamom.

Medicine.

The seeds yield a MEDICINE in the shape of an agreeable stimulating oil with an aromatic camphoraceous taste. It is considered carminative and stomachic, but this so-called Greater Cardamom is medicinally only a cheap substitute for the common or Malabar Cardamom (***Elettaria Cardamomum***, of which there is both a large and a small kind, see pp. 511–2). The seeds are also much used in the preparation of SWEETMEATS owing to their cheapness (Rs. 12 per maund of 37½ lb., *Pharmacog. Ind., l.c.*). The present Cardamom is also used in the preparation of *bhang-massála* (see **Cannabis sativa**, p. 258, and *Ind. Hemp Drugs Rept.*, 1894, iv., 50, 152, etc.). The seeds of ***A. xanthioides***, *Wall.* (*iláyechi-dáné*), are imported from Siam and Singapore and sold in the Indian bazárs. The smell and taste are said to be stronger than those of ***Elettaria Cardamomum*** but not so pleasant. [*Cf.* Sonnerat, *Voy. aux Ind. Or. Planch.*, pl. 137. For ***A. aromaticum***, *Roxb., cf. Kew Rept.*, 1877, 27.]

Sweetmeats.

AMORPHOPHALLUS CAMPANULATUS, *Blume; Fl. Br. Ind.*, vi., 513; *Pharmacog. Ind.*, iii., 546; Mollison, *Textbook Ind. Agri.*, iii., 189–91; AROIDEÆ. Elephant's Foot, *zamin-kand, ol, surana, jangli-suran, karunai-kizhangu, kanda-godda, wa*, etc. A tuberous rooted herb found on the plains of India from the Panjáb to Bengal, the Deccan and Ceylon, cultivated in rich moist soils.

D.E.P., i., 225-7. Ol.

Allied Plants.

Synantherias sylvatica, *Schott.*, an allied plant met with in the Deccan, is regarded by the Hindus as a kind of wild *surana*, and ***Sauromatum guttatum***, *Schott.*, a species of the plains of Upper India and the Konkan, ascending the Himalaya to 5,000 feet in altitude, has similiar medicinal characteristics, but these are too unimportant to justify independent positions in this work. In MEDICINE the corms and also the seeds of ***Amorphophallus*** are used as external irritants to relieve rheumatic swellings. Confections of the tubers (corms) with treacle, aromatics and Plumbago-root are given in cases of piles and dyspepsia. One of the Sanskrit names of the plant is *arsogna*—"destroyer of piles." The wild tubers peeled, cut into segments and dried by being strung, constitute the *madan-mast* of the shops. The cultivated corms are cooked and form a common article of FOOD with the poor. They are boiled like potatoes, cooked in curries and pickled or preserved.

Medicine.

Madan-mast.

Food.

Mollison says the crop is important chiefly in the Gujarát and Baroda territory. He gives the accumulated cost of cultivation in the fourth year (Surat district) as Rs. 484 per acre and observes that the cultivation can accordingly be undertaken only by well-to-do persons. In Bengal the average crop under favourable circumstances is about 200–400 maunds per acre and the price about Rs. 2½ per maund, and Duthie and Fuller (*Field and Garden Crops*, iii., 6, pl. 69) say the bazár price at Saharanpur is 2 annas per seer (Rs. 5 per maund). The tubers are usually planted out in May to June, and in 12 months they are fit to be dug up. If properly cultivated each tuber will weigh from 2 to 10 lb., or as much as 40 lb. [*Cf. Ann. Rept. Govt. Exper. Farm, Poona, Bomb.*, 1896, 15.]

Production.

ANACARDIUM OCCIDENTALE, *Linn.; Fl. Br. Ind.*, ii., 20; Gamble, *Man. Ind. Timbs.*, 214; *Pharmacog. Ind.*, i., 385 and 548; Cooke, *Fl. Pres. Bomb.*, i., 274; *Agri. Ledg.*, 1899, No. 12, 146; ANACARDIACEÆ. The Cashew-nut, *kátú, hijli, bádam, mundiri, kottai, jidi-mámidi vittu, jidi váte*, etc. A tree originally introduced from South America, but now established in the coast forests of India, especially in sandy places,

D.E.P., i., 231-3. Cashew-nut.

where it is often gregarious. In South India it is important in coast-dune reclamation.

Gum.
Oils.
Medicine.
Food.
Timber.
Trade.

The bark yields a GUM which is obnoxious to insects. The juice which issues from incisions in the bark is used as an indelible marking-ink. The bark and the pericarp yield an OIL (called *dik*), which is occasionally employed to tan fishing-nets. Two OILS are obtainable from this plant: (1) a light-yellow from the pressed kernels, of which the finest quality is equal to almond oil; and (2) "Cardole," obtained from the shell of the nut—an acrid and powerful fluid efficacious for preserving carved wood, books, etc., against white ants. It is used as a rubefacient and vesicant MEDICINE. The spirit distilled from the juice of the fruit and sold when redistilled at about Rs. 1½ per gallon, is a useful stimulant and the fruit itself has antiscorbutic properties. The seeds, known as Cashew-nuts, are usually eaten roasted and are made into confectionery with sugar. The fruit-pedicels are also eaten. The TIMBER (weight 30 to 38 lb. per cubic foot) is used for packing-cases and for boat-building and charcoal. Cashew-nuts are imported into Bombay from Goa in very considerable quantities. The kernels are valued at about Rs. 18 per cwt. [*Cf.* Garcia de Orta, 1563, *Coll.*, v.; Acosta, *Tract. de las Drogas*, 1578, 232; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), 1598, ii., 127; Acosta, 1598, in Clusius, *Exot. Pl.*, 1605, 272; Garcia de Orta in Clusius, *Exot. Pl.*, 1605, 198; Boym, *Fl. Sin.*, 1656, C.; Milburn, *Or. Comm.*, 1813, i., 273; etc., etc.]

D.E.P.,
i., 236 9.

ANANAS SATIVA, *Schult.*; BROMELIACEÆ.

Shortly after the discovery of America the Pine-apple appears to have been dispersed rapidly over the world and acclimatised in most tropical countries. The Spaniards called it *Pinas* because of its resemblance to the pine-cone, but the Portuguese adapted to their own tongue its Brazilian name *Nanas* and called it *Ananas*, a word which in some form or other has accompanied the plant throughout the world. In most of the languages of India it bears names clearly derived from the Brazilian, such as *anánas*, *anánash*, *anáras*, *anáshappazham*, *na-nát*, *anása*, etc. Or it is called Foreign Screwpine, European Jack Fruit, etc.—all modern names. There are no names for it in any of the classic languages of Europe, Asia, Arabia or Egypt.

Introduction into India.
Early Travellers in India.

History. Oviedo (*Hist. de las Ind.*, 1548 (ed. 1853), iii., 280–4) described the plant as grown in the West Indies and on the American mainland, and Christopher Acosta (in Clusius, *Hist. Exot. Pl.*, 1605, 284) speaks of it as plentiful in India. He mentions a wild form in the Deccan called *queura*, which suggests a confusion with ***Pandanus odoratissimus***. and it is curious that Abul Fazl (*Ain-i-Akbari* (Blochmann, transl.), 83) should contrast the leaves of the *kewrah* (***Pandanus***) with the maize—a plant then only recently introduced into India. Marcgraf (in Piso, *Ind. Utri re Nat. et Med.*, 1658) mentions the pine-apple in Brazil, and Hernandez (1651) in Haiti and Mexico. It is figured and described by most botanists of the 16th to 18th centuries, *e.g.* J. Bauhin (1651), Boym (*Fl. Sin.*, 1656), Ligon (*Hist. Barbados*, 1657), Bontius (in Piso, *l.c.* 1658), Rheede (*Hort. Mal.*, 1692, xi. tt. 1–2), Merian (*Insect. Surinam*, 1705, tt. 1–2), Rumphius (*Herb. Amb.*, 1750, v., 228), etc., etc. Boym speaks of it as brought from India to China. Rheede (confirming Acosta) declares it to have been introduced by the Portuguese, but less than a century later it had become so common as to be considered indigenous by Rumphius. Marco Polo naturally says nothing of it, and the reference usually given to Garcia de Orta is properly a note by Clusius contrasting Garcia's description of the Mango with Oviedo's description of the pine-apple. It is mentioned prominently by Linschoten, Pyrard, Bernier, Herbert and other travellers, and Jahangir (*Memoirs* (Price, transl.), 13–4) alludes to its introduction, but the Emperor Baber (1519) does not include it in his list of the fruits of Hindustan. Finally in 1800, Buchanan-Hamilton wrote that it was regarded as the fourth most important fruit in Dinajpur. [*Cf.* Herbert, *Travels*, 1677, 334; Turner, *Acc. Emb. Tibet*, 1800, 13–5; *Taleef Shereef* (Playfair, transl.), 1833, 17; *As. Journ.*, 1819, vii., 264; Watson, *Journ. As. Soc., Beng.*, 1834, iii., 27; Bennett, *Wanderings N.-S. Wales*, 1834, ii., 208–9; Logan, *Pina Cloth, Journ. Ind. Archi.*, 1848, 528; De Candolle, *Orig. Cult. Plants*, 1884, 311–2; Blechynden, *Journ. Agri.-Hort. Soc. Ind.*, 1889, viii., n.s., pt. iii., 351–68 ; Barber, *Notes on Antigua Pine*, 1892–3 ; Nicholls, *Textbook Trop. Agri*, 1892, 174–7 ; *U.S. Dept. Agri. Fibre Invest. Rept.*, 1893, No. 5 ; *Pine-apple Growing, Farmer's Bull.*, 1901, No. 140 ; *Produce World* (ser. of art.), 1896–7 ; *Agri. Ledg.*, 1898, No. 11 ; *Settl. Rept.*, *Bassein* (Burma), 1899, 19–20 ; *Kew Bull.* (add. ser. ii.), 1898, 109 ; Watts, *Pine-apple Cult. in Antigua*, *West Ind. Bull.*, ii., 113–21 ; N. G. Mukerji, *Handbook Ind. Agri.*, 330–2 ; *Pine-apple Cult.*, in *Agri. Bull. Straits and Malay States*, iii., Nos. 1, 2.]

Fruit.

Cultivation in Europe.

Modern Trade.

Cultivation for Fruit.—The English hot-house pine-apples are often spoken of as much superior in flavour to those grown in tropical countries. The fruit appears to have been first cultivated in Europe at Leyden in 1650, and the first pine-apple grown in England was raised in the Duchess of Cleveland's hot-house at Downey Court and presented by her gardener (Mr. John Rose) to King Charles the Second some time before 1672—the date at which Rose became the Royal gardener. [*Cf.* Murray, *Hist. Roy. Hort. Soc.*, 1863, 4 and pl.] With the modern facilities of rapid transport to Europe and America, large supplies of the fruit have recently reached these continents from the West Indies, from Madeira and from the Canary Islands. This has led to a decline in hot-house cultivation, to an immensely increased supply and consequent great reduction in price, and has given birth to a highly lucrative new planting industry in all tropical countries situate within practical access of the European and American markets.

Cultivated Forms.

Indian Supply

Much attention has recently been given to the study of the varieties and races of pine-apple, as also to the methods of cultivation and markets of supply and demand. In India, while the plant is extremely abundant as a fruit grown in gardens and in some localities has even become completely acclimatised, little or no effort has been put forth either to improve the quality or to develop, on a commercial basis, the industry of pine-apple growing, which it would appear might be originated with advantage to India and profit to those concerned.

Western India.

Eastern Distribution.

Essential Conditions.

Climates and Localities.—The pine-apple was first introduced on the West coast of India, but rapidly crossed the country and attained its greatest perfection in the Eastern Peninsula. From Calcutta through Eastern and Northern Bengal to Assam and Burma may be said to be its best Indian habitat, though it also occurs here and there throughout India, and is very abundant on the Western Ghats, especially on their southern extremity. Speaking of Bengal, Thevenot (*Travels, Levant, Indostan, etc.*, 1687, pt. iii., 68) mentions the pine-apple growing as large as a melon. In Assam (more particularly the Khasia hills) it might also be said to exist as a wild plant and yields a profusion of most delicious fruit. In Tenasserim it has become so completely acclimatised and is so abundant that, as observed by Dr. Helfer many years ago, a boat-load of fruit might be purchased in June or July for one rupee. It is thus not by any means exclusively on the littoral tracts, nor within the inundated areas of India, that the pine-apple has attained its greatest perfection, but rather considerably inland and on the dry, sandy loams of the lower hills and terai, though in tracts of country subject to a high annual rainfall. A warm, moist atmosphere and a well-drained sandy loam would appear, therefore, to be the essentials for success with pine-apple.

Indian Varieties.

Varieties.—Indian writers allude to only one or two recognisable varieties. Firminger, for example, speaks of the Sylhet or *koomlah* pine—a small fruit with very few but exceptionally large eyes ; and the Dacca—a remarkably smooth pine with white eyes. He then discusses imported pines, such as the Ceylon, Penang and several English hot-house forms, occasionally met with in the fruit gardens of Europeans. Practically, therefore, little or nothing has been published as to the cultivated races of the plant met with in India.

Sandy Loams.
Rich Soil Recommended.
Dried Fish.
Shade.
Watering.

Soils, Manures, etc.—Nicholls says the best soil is a sandy loam with good drainage, and next come the free sands and gravels. Clay of all kinds and badly drained lands are unsuited. A good proportion of lime is advantageous, but animal manure, unless perfectly rotted, should not be put near the plants as it is inimical to their growth. Speede, one of the earliest of Indian practical writers, on the other hand, affirms that no soil can be too rich and no manure too strong for pine-apples. Woodrow recommends dried salt-fish as a manure, and urges that during the first opportunity of dry weather in the monsoons the manure should be dug into the soil. But as opposed to such views, and in support of the West Indian experience, Firminger tells us that he found the plants to rot and perish from an oversupply of manure. Further that a soil thoroughly lightened with leaf-mould, well-decayed cow-dung and sand, may be mentioned as that on which pine-apples will thrive to perfection. He then urges that shade of any kind is to be avoided, as it will increase the size of the fruit but greatly injure its flavour. Repeated watering, as the fruit forms, is essential. Firminger further urges, as of great importance, that the plants should be removed after comparatively short intervals to new soils. On this subject Nicholls remarks that after three or four years the plants show signs of exhaustion, and they must in that case be uprooted and the land prepared for fresh stock.

By Crown of Leaves.
By Seeds.
Plants to the Acre.
Continuous Cultivation.

Propagation and Seasons.—When the fruit has formed, numerous suckers will be found around the parent stem. These are preferably selected for propagation, though of course plants may be raised from the crown of leaves taken from the fruit, and even from the black seeds often found within the fruit itself. In the West Indies it is stated that in lining an estate the distances apart at which the suckers are to be planted should not be less than 3 feet, which would give nearly 5,000 plants to the acre. Nicholls adds, however, that " a better plan would be to line out the land in rows 6 feet apart, and to plant the suckers at a distance of 3 feet in the rows—this would allow nearly 2,500 plants to the acre ; and after the first crop a few of the suckers, say four to each plant, could be left, and then this would give nearly 10,000 fruits for the second crop." It is most important to have fairly large spaces between the rows, since the plants being spiny the necessary room for working the land has to be provided. Moreover, after uprooting and preparing the land for re-lining it is possible to set the new plants on the interspaces not occupied by the former crop, and thus to continue cultivation on the same land very nearly indefinitely.

Seasons.
Cold-season Fruit.

The fruit comes into season in the West Indies in from eight to nine months from the time of planting. Firminger says that for the Lower Provinces of India the proper season for planting out pine-apple is in August. The plant flowers in February and March and ripens its fruits in July to August, after which, in September and October, it makes its perfect growth. It sometimes happens, however, that it breaks into flower during the latter months and produces fruit in the cold season—most undesirable condition, since without heat the fruit cannot ripen and is accordingly acid and uneatable. On the other hand, Woodrow, writing of the Bombay Presidency, says that strong suckers may be planted between January and March and watered until roots are formed.

Produce.

Packing.—The fruit should be cut off with a sharp knife through the middle of the stalk and a little before it is fully ripe. In dispatching to a distance each fruit should be wrapped in straw or paper, and deposited if possible in a separate compartment made for itself, or at most a compartment for two or three fruits. When either bruised or over-ripe, fermentation takes place and the entire consignment may be ruined through the presence of one fermenting fruit.

Fermentation of Bruised or Over-ripe Fruit.

Fibre.

Production of Fibre.—The leaves afford a superior fibre, which in the Philippines is woven into a beautiful fabric called *pina* (or *pigna* = Spanish for a cone) or *batiste d'ananas*, a fabric resembling the finest muslin. In the Rangpur district, Northern Bengal, the fibre is in considerable demand for the string said to be used by the shoemakers. It is also employed for necklaces in the Southern Maratha country (Goa). Jenkins drew attention to the Khasia pine-apple fibre in 1836 (*Trans. Agri.-Hort. Soc.*, 1867, iii., 137), and Wallich purchased, on the Khasia hills in that year, a bag made of the fibre. Royle speaks of supplies of the fibre obtained from Madras. It will thus be seen that the fibre is by no means unknown in India, though little or no progress has been attained in the establishment of a commercial supply. In 1887 Mr. Weynton read a paper before the East Indian Association on the commercial prospects of Assam, in which he made special reference to Sylhet as a country in which pine-apple fruit, fibre and alcohol might be produced. Recently Sir J. Buckingham, then of Amguri, Assam, furnished the Reporter on Economic Products with a sample of the fibre. This was forwarded to the Imperial Institute, London, for opinion and valuation. The late Sir F. A. Abel furnished in reply a most encouraging report, which will be found in *The Agricultural Ledger* (1898, No. 11). The fibre was found to be fully up to the quality of any hitherto seen in London, and it was thought would probably fetch £20 to £25 per ton.

Philippine *Pina* Cloth.

String.

Necklaces.

Khasia Bags.

Prospects of Assam.

For particulars regarding the method of separation of fibre, the machinery employed and the yield obtained in America and other countries, the reader must consult the publications enumerated. Though much advantage might be expected to accrue to India from the organisation of a pine-apple fruit and fibre industry, the fact that so little interest is taken in the subject precludes more detailed treatment in this work.

Methods of Separation.

Minor Uses.—In conclusion it may be added that the minor uses of the pine-apple, such as its reputed MEDICINAL properties, the prospects of an industry in the manufacture of alcoholic or other beverages from the juice, also vinegar (see p. 1109), as well as the industrial utilisation of the plant, have been purposely excluded from consideration.

Medicine.

Alcohol and Cider.

ANDROGRAPHIS PANICULATA, *Nees; Fl. Br. Ind.*, iv., 501; *Pharmacog. Ind.*, iii., 46; ACANTHACEÆ. The Creat, *kiryát, kalmeg, olen-kitaita, shirat-kuchchi, nela-vemu, nila-veppa, néla-bevinagida, kiryato,* etc. An annual bitter shrub common throughout the plains of India, from Lucknow to Assam and Ceylon, also cultivated in gardens.

D.E.P., i., 240-1. Creat.

This forms the principal ingredient of a household MEDICINE called *aluí*, which is extensively used in Bengal. The expressed juice of the leaves with certain spices, such as cardamoms, etc., dried in the sun, is made into little globules and given to infants to relieve griping, etc. The roots and leaves are febrifuge, stomachic, tonic, alterative and anthelmintic. The drug has been

Medicine.

advertised in England under the name *Halviva* (perhaps a corruption of *aluí*), as a substitute for quinine. [*Cf. Brit. Med. Journ.*, March 7, 1891; *Proc. Agri.-Hort. Soc. Ind.*, 1892, ccxv.; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 148, 157, 327.]

D.E.P., i., 241-52.

ANDROPOGON, ***Linn.***; *Fl. Br. Ind.*, vii., 164–210. A genus of Grasses (GRAMINEÆ) by botanical writers usually referred to several sub-genera. Sir J. D. Hooker (*Fl. Br. Ind.*) has, for example, accepted eleven, but Dr. Alfred Barton Rendle, in the *Catalogue of Welwitsch's African Plants*, gives only six (which practically correspond to as many in the Flora of British India), while he restores ***Cymbopogon, Heteropogon, Sorghum*** and ***Vetiveria*** to independent positions.

In point of botanical structure there is perhaps little justification for the separation of these four genera, but as a matter of expediency (more especially from the standpoint of economic botany) it is most desirable that ***Andropogon*** should be broken up into a few independent groups or genera. This view was taken when the original edition of the *Dictionary* was penned, and it is believed the majority of botanists, including Hooker himself, would not seriously oppose the four genera named being treated as distinct from ***Andropogon.*** He has in fact (*Handbook Fl. Ceylon*, pt. v., 228) admitted that some such view will have to "be eventually adopted." I have, accordingly, resolved to assort the available economic information regarding these plants as follows:—

1. ***Andropogon citratus,*** *DC.*, as in Watt, *D.E.P.*, 242–3; see under ***Cymbopogon Nardus,*** *var.* ***citratus*** (p. 459). [*Cf.* Stapf, *Kew Bull.* 1906, 357–8.]

2. ***Andropogon contortus,*** *Linn.*, and ***Heteropogon hirtus,*** *Pers.* = ***H. contortus,*** *Beauv.*

3. ***Andropogon halepensis,*** *Brot.*; see ***Sorghum halepense,*** *Pers.* (p. 1031).

4. ***Andropogon Jwarancusa,*** *Jones*; ***A. laniger,*** *Duthie* = ***Cymbopogon Jwarancusa,*** *Schult* (see p. 461). [*Cf.* Stapf, *l.c.* 354.]

5. ***Andropogon laniger,*** *Desf.*; ***A. Schoenanthus,*** *Linn.*, *Sp. Pl.*; ***A. Jwarancusa,*** *subsp.* ***laniger,*** *Hook., f.* = ***Cymbopogon Schoenanthus,*** *Spreng.* (see p. 461). [*Cf.* Stapf, *l.c.* 352–3.]

6. ***Andropogon Martini,*** *Roxb.*; ***A. Schoenanthus,*** *Fluck. & Hanb.*; ***A. Schoenanthus,*** *var.* ***Martini,*** *Hook., f.* = ***Cymbopogon Martini,*** *Stapf, l.c.* 359–60 (see p. 451).

7. ***Andropogon muricatus,*** *Retz.*; ***A. squarrosus,*** *Linn., f*, and ***Anatherum muricatum,*** *Beauv.* = ***Vetiveria zizanioides,*** *Stapf* (see p. 1106).

8. ***Andropogon Nardus,*** *Linn.*; see ***Cymbopogon Nardus,*** *Rendle* (p. 455). [*Cf. Stapf, l.c.* 354–5.]

9. ***Andropogon odoratus,*** *Lisb.*, in *Journ. Bomb. Nat. Hist. Soc*, 1889, iv., 123 and t.; 1891, vi., '68, 203; also *Bomb. Grasses*, 1896, 70; *Fl. Br. Ind.*, vii., 177; Stapf, *l.c.* 363. This sweetly scented grass, Mrs. Lisboa says, bears the following vernacular names—*vaidia-gavat, usad hana, bhos, tambrut.* It is common at Lanowli, Poona, etc., and at the end of the rains gives a purple colour to the countryside. The authors of the *Pharmacographia Indica* (iii., 570-1) observe: "We have distilled the grass and obtained from it an essential oil, having at first an odour recalling that of cassia and rosemary, but afterwards a strong persistent odour of oil of cassia. Messrs. Schimmel & Co. noticed the odour of pine-needle oil in this sample, and found the sp. gr. to be 0·945." . . . "The yield of oil from the grass was equal to that obtained from ***A. Schoenanthus***; it had a deep sherry colour, a sp. gr. of 0·931 compared to an equal volume of water at 84° F." [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 299.]

10. ***Andropogon Schoenanthus,*** *Linn*, *Sp. Pl.*; ***A. laniger,*** *Desf.*; and ***A. Jwarancusa,*** *subsp* ***laniger,*** *Hook, f.* = ***Cymbopogon Schoenanthus,*** *Spreng* (see p. 461). [*Cf.* Stapf, *l.c.* 252.]

ANILINE AND ALIZARINE (see Coal Tar, p. 344).

D.E.P., i., 256 8.
Dhaúra.

ANOGEISSUS LATIFOLIA, ***Wall.***; *Fl. Br. Ind.*, ii., 450; Gamble, *Man. Ind. Timbs.*, 346; COMBRETACEÆ. The *dhaúra, dháuri, dhavada, hesel, bákli, arma, vellay naga, chiriman*, etc. A large deciduous tree of the Sub-Himalayan tracts from the Ravi eastward to Central and Southern India. Ascends to 3,000 feet in altitude.

Gum.

Dhaura GUM is used in calico-printing and has been suggested as likely to be useful to dyers in England (*Journ. Chem. Soc. Indust.*, Dec., 31, 1887, 79). It is largely exported, and constitutes the bulk of the Gum Ghati sold in Bombay (see **Acacia**, pp. 15, 17). [*Cf.* Hooper, *Edible Gum*, *Rept. Labor. Ind. Mus.*, 1904–5, 23.] The leaves yield a black DYE and a TAN. Hummel (*Select. Rec. Govt. Ind.*, 1888–9, 93) valued the leaves for tanning purposes at 4*s.* 2½*d.* per cwt. (about one-third of the relative value of *divi-divi*). A tanning extract has been prepared from the bark by Hooper, containing 43·8 per cent. of tannin. The TIMBER is strong and tough, but splits in seasoning and will not stand damp. It is used for axe-handles, axles, etc., also in furniture-making and ship-building, and has been recommended for railway sleepers. It gives a good fuel and charcoal. The white-wax insect (***Ceroplastes ceriferus***) has been reported as found on this tree. Other two species of economic interest are— ***A. acuminata***, *Wall.*, *chakwa*, *panchi*, etc., met with in Bengal, South India and Burma, which yields a poor TIMBER; ***A. pendula***, *Wall.*, *dhau*, *dhaukra*, etc., a small gregarious tree of the dry forests of Rajputana and Bandelkhand, which coppices well and yields a timber much like that of ***A. latifolia***.

Dye and Tan.

Timber.

ANONA SQUAMOSA, *Linn.*, and **A. RETICULATA**, *Linn.*; *Fl. Br. Ind.*, i., 78; *Pharmacog. Ind.*, i., 44; ANONACEÆ.

D.E.P., i., 259-61.

Custard-apple.

The former is the CUSTARD-APPLE of Anglo-Indians, SWEET-SOP or SUGAR-APPLE (West Indies and America), *sharifah*, *sitaphal*, *áta*, *lúna*, *sítá-palam*, *sítá-punda*, *auza*, *duranji*, etc. A small tree native of tropical America but much cultivated in India. In Central and Western India it occurs wild and so abundantly as almost to constitute forests. The latter is the Bullock's Heart, or *ramphal*, *ramsita*, which yields an inferior fruit sometimes eaten.

Fibre.

Medicine.

The bark affords an inferior FIBRE and the fruit, bark, leaves and roots are used in MEDICINE, the latter being considered a drastic purgative. The crushed leaves are applied to the nostrils of women in hysterical or fainting fits. Dymock informs us that the seeds yield an OIL and three RESINS: the latter appear to be the acrid principles and are useful as INSECTICIDES. The same quality is ascribed to the leaves and immature fruits. The FRUITS are eaten by both Natives and Europeans, and in the West Indies a kind of cider is made from them. The fruits of the wild plant have proved useful in famine. The cultivation is said to be simple. The seeds, obtained fresh from the fruit, are sown in pots about the middle of February. The seedlings are transplanted into holes 3 feet deep by 3 feet diameter, which have been filled with cow-manure, old mortar and garden soil in equal parts. The trees should be pruned and re-manured every March or April and well watered until the rains set in (J. H. Dieves, *Ind. Gard.*, Feb. 23, 1899). The Custard-apple is in season in Bengal during the greater part of the rainy and cold months (Firminger), and constitutes one of the chief fruits of that season. Another species, the *Chirimoya* of Peru (***A. Cherimolia***, *Miller*), is cultivated in parts of Burma for the fruit, and it appears to do well [*Cf.* *Land Rec. Admin. Rept.*, Rangoon, 1904, 18.]

Insecticide.

Food.

Propagation.

ANTIARIS TOXICARIA, *Lesch.*; *Fl. Br. Ind.*, v., 537; Gamble, *Man. Ind. Timbs.*, 651; URTICACEÆ. The Upas Tree, *jasúnd*, *karwat*, *alli*, *jazúgri*, *aranjili*, *hmyaseik*, etc. A gigantic tree of the evergreen forests in Burma, the Western Ghats and Ceylon.

D.E.P., i., 266-9.

Upas Tree.

Habitat.

Very full accounts of the legendary attributes of this tree and of the investigations into the subject may be found in the above-named works, and also in the *Pharmacographia Indica* (iii., 348–55), Yule and Burnell (Anglo-Ind. Gloss.. *Hobson-Jobson*, 952–9), and the *Kew Bulletins* for February, October and November, 1891. The tree exudes a white RESIN used for poisoning arrows. [*Cf.* Lewin, *Die Pfeilgifte*, 1894, pt. iii., 301, etc.] The inner bark gives a FIBRE which makes strong cordage. The Natives strip the bark into large pieces, soak them in water and beat them to obtain the white fibre. In Western India the tree is known as the "Sacking-tree," because the tough bark is stripped off whole from branches or young trees to form rice-sacks, a section of the stem being left to serve as a bottom to each sack. The seeds are said to be used in

Resin

Fibre.

Sacking--tree.

Medicine as a febrifuge and anti-dysenteric. [*Cf.* Horsfield, *Plantæ Javanicæ rariores*, 1852, 52–62.]

D.E.P., i., 270 1. Antimony.

ANTIMONIUM or ANTIMONY ; Ball, *Man. Econ. Geol. Ind.*, 163-7; Holland, *Rec. Geol. Surv. Ind.*, xxxii., 97. The *surmá, surmah-i-Isfahani, anjan, anjanak-kallu, anjanam, ismad*, etc. A black ore of antimony or tersulphide.

Type-metal.

Cosmetic.

Antimony-sulphide (stibnite) occurs at Shigri in Lahoul, also in the Jhelum district of the Panjáb, and in Tenasserim of Burma. Large quantities of the ore, containing gold, have also been discovered in the Amherst district of Burma. Natives do not seem to utilise this metal as an alloy. Its chief use is in the manufacture of type-metal. It is employed by the ladies as a cosmetic, but much of the antimony sold for that purpose is really *galona* imported from Kabul and Bokhára, which is often confused with antimony.

D.E.P. i., 271-2. Celery.

APIUM GRAVEOLENS, ***Linn.*** ***: Fl. Br. Ind.***, ii., 679; Umbelliferæ. Celery, *ajmúd, chanú, ajwan-kaputa, karafs*, etc.; commonly called *salerí* in Indian bazárs.

Medicine.

Food.

A glabrous herb native of England and other parts of Europe, and widely distributed—*e.g.* to North Africa and the shores of New Zealand. It is cultivated in different parts of India during the cold weather, chiefly in gardens near towns for the use of the European population. It is also cultivated in Bengal for its seed and in the Panjáb for its root. In Medicine the officinal root is considered alterative and diuretic, and the seeds are given as stimulant and cordial. Cooked celery is said to be useful in rheumatism. The seed is eaten as a Spice by the Natives, and the blanched stems and leaf-stalks by Europeans. In the wild state it is, to a certain degree, poisonous. [*Cf.* Forster, *Pl. Esc.*, 1786, 67; *Paulus Ægineta* (Adams, Comment.), iii., 106; *Pharmacog. Ind.*, ii, 122–4; *Queensland Agri. Journ.*, 1903, xiii., 257; U.S. Dept. Agri., *Farmer's Bull.*, 1902, No. 148.]

D E.P., i., 278 82. Eagle-wood.

AQUILARIA AGALLOCHA, ***Roxb.*** ***: Fl. Br. Ind.***, v., 199–200; Gamble, *Man. Ind. Timbs.*, 579; *Pharmacog. Ind.*, iii., 217; Brandis, *Ind. Trees*, 546; Thymelæaceæ. Calambac, Aloe- or Eagle-wood, the Aloes or Lignum Aloes of the Scriptures, *agar, ugur, ugal, úd, sasi, akyaú, kayu, garu*, etc. The Sanskrit *agaru* (*a* privative, and *garu* heavy—a name given to it from the circumstance that it does not float on water) is the root from which most of its vernacular names have been derived. *Laghu* or *lauha*, another Sanskrit and Pali synonym, is supposed by some to be the origin of the expression Aloes-wood—and might therefore be accepted as denoting a light form that would float on water.

Habitat.

It is a large evergreen tree of the Bhutan Himalaya, Assam, Khasia hills, Eastern Bengal and Martaban hills (Burma). It attains a height of 60 or 70 or 100 feet and a girth of 5 to 8 feet. It is fit to be cut down for *agar* collecting at 20 years, but some authors consider it is not mature until 50 or 60 years. Another species, ***A. malaccensis,*** *Lamk.*, is supposed to be the Eagle-wood of Malacca and of Tenasserim.

Perfumery.

Fragrant Resin

A review of the recent information collected by the Reporter on Economic Products (written by Hooper) will be found in *The Agricultural Ledger* (1904, No. 1). The wood in its ordinary state is not of much value, being pale in colour, light and inodorous. But under certain conditions a change takes place in both trunk and branches, the wood becoming gorged with a dark resinous, aromatic juice, which gives it a greater specific gravity. The portions thus impregnated are collected and constitute the drug called *agar*, which is esteemed in proportion as it abounds in resinous matter. In no other part of the tree is this fragrant resin deposited. There is no external mark by which to recognise good from bad trees; they have to be cut down to discover the resin, which is only rich in one out of twelve. The average yield of a mature tree is 6 to 8 lb., and an exceptionally good tree may afford as much as Rs. 300 worth of *agar*. It is difficult to decide what is the predisposing cause of the secretion of this oleo-resin, but the majority of forest officers are of opinion that it is usually, if not always, found where some former injury has been received. The old tradition mentioned in the *Ain-i-Akbari* (Blochmann, transl., 80), that the branches were lopped off and buried in the ground in order to cause the formation of the resin, has been completely exploded by modern research.

Grades and Prices.

The DRUG occurs in pieces of extremely irregular shape and size. The largest rarely exceeds a pound in weight, while some of excellent quality is met with as small chips or splinters. The lighter portion of wood called *doom* is the cheapest and is sold for Rs. 1 to Rs. 3 a seer, the black or brownish-black is the true *agar* of commerce and is called *ghurkee*; it is worth from Rs. 16 to Rs. 20 a seer. The *Ain-i-Akbari* (*l.c.* 81) gives full directions for the distillate called *chuwah*, used in perfumery.

Medicine.

From ancient times *agar* has been used all over the East on account of its perfume and its supposed MEDICINAL qualities. It is alluded to repeatedly in *The Bower Manuscript* as *aguru* (Hoernle, transl., 21, 23, 104), which may be described as a medical treatise which dates from the 5th century. It is to-day employed largely in China, and utilised as incense and in the manufacture of joss-sticks. It is met with in most Eastern bazárs, including those in Syria, where Hanbury found it for sale. In Sylhet a certain quantity is collected each year for the sake of extracting from it a sort of essential oil (*agar-attar*), which is considered as costly as *attar* of roses. In Bombay *agar-batis* or *agar*-lights are made of various sweet-smelling substances of which aloes-wood is the chief ingredient. These sticks are burned as incense or are used to perfume apartments. Marco Polo, Garcia de Orta, Varthéma, Barbosa, Linschoten, Herbert and many other of the early European visitors to India allude to Eagle- or Calambac-wood, although in some cases it may be questionable whether it is the present plant. They one and all attribute, however, the finest quality to Cambodia, or to some part of the Malay Peninsula or Archipelago. Prebble, speaking of the present traffic, says the best quality, imported into Bombay, comes from Bankok. He mentions two well-known trade qualities, the *gagali* (**A. Agallocha**) and the *mawardi* (**A. malaccensis**). Do these correspond to the *gharki* and *mandalí* of the early writers? To **A. malaccensis** has very possibly to be referred the *jangli agar* and the Singapore *agar* of the Bombay market. But the Sylhet *agar* holds an honourable position. Various qualities are mentioned by most of the early writers such as Abul Fazl (in the *Ain-i-Akbari, l.c.*). Roxburgh wrote a long and highly instructive article on **A. Agallocha**, which was followed by an article by Henry Thomas Colebrook. These two papers give practically all that is known of the Indian Agar-wood (*Trans. Linn. Soc.*, 1855, xxi., 199–206, pl. 21). Rumphius some time previously described two kinds of true and two kinds of false aloes-wood. The first of the true forms he says was the *kilam* of the Chinese and *calambas* of the Malays, and was obtained from Cambodia; the second true form was the *garo* or *garu* (a word that may be accepted as the Malayan variant of *agaru*)—both are possibly varieties of **A. malaccensis**. According to the authors of the *Pharmacographia Indica* the best MEDICINAL quality is the *gharki úd* from Sylhet. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 18; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), i., 335; ii., 360; Clusius, *Hist. Exot. Pl.*, 1605, 172; Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 204; Herbert, *Travels*, 1677, 333; Milburn, *Or. Comm.*, 1813, ii., 312–3; Birdwood and Foster, *E.I.C. First Letter Book*, 337, 340, 406, 410, 427–8; Buchanan-Hamilton, *Comment. on Herb. Amb.*, in *Mem. Wern. Soc.*, 1832, vi., 276; Taylor, *Topog. Stat. Dacca*, 250; Hooker, *Him. Journ.* (ed. 1854), ii., 328; Moeller, in *Pharm. Post.*, 1896, 1898; Holmes, *Mus. Rept., Pharm. Soc. Gt. Brit.*, 1895-1902, 39–45]. The last-mentioned work is an exceedingly instructive review of Moeller's results, and republishes his illustrations of microscopic sections of the various forms of the wood, etc., etc.

Agar-attar.
Agar-batis.
Present Traffic.
Sylhet Agar.

Natural Paper.

Mr. E. A. Gait, who was director of Land Records and Agriculture, Assam in 1894, drew attention to the fact that the bark of **Aquilaria Agallocha** affords a NATURAL PAPER that appears to have been used for ages by the aboriginal tribes of Assam, like the birch bark of the Aryans. The information then collected will be found in a paper on the *Abstract of Contents of one of the Ahum Puthis* (*Journ. As. Soc., Beng.*, 1894, lxiii., pt. i., No. 2), from which the following may be given: "Although the bark was widely used as a writing-material throughout Assam, prior to the introduction of paper, its employment as such seems to have escaped notice. Brahmins and Goshais in the habit of performing religious ceremonies in the houses of their disciples or in the presence of the gods in the temple, consider it impure to have their *mantras* written on mill-made paper and, therefore, retain the custom of writing their sacred books on the prepared bark of the *sachi* tree." Loureiro says that the common paper of the Cochin-Chinese is made of the bark of ***A. malaccensis.*** Besides forming the leaves of books the bark is sometimes used as covers for binding books. The Nagas and other hill tribes prepare strips of the bark by which they hang their baskets on the forehead. The FIBRE is employed for making ropes, but it is not very lasting.

Taggar Wood.

Taggar Wood, according to Holmes, is a dark-brown timber exported from Madagascar to Zanzibar, and thence to Bombay, but Colebrook so long ago as 1851 spoke of it as a wood sold in Bengal to the unwary as a substitute for *agar*. Dick, in a letter to Roxburgh, gave *tuggur* as the Bengali name for a wood found in the hills near Sylhet, a geographical reference that might suggest ***Excœcaria Agallocha***, a plant known by various Indian names such as *thilla, tilai,* and *tayaw kayaw* in Burma, and *tala kiriya* in Ceylon. So far as Roxburgh was aware, however, it did not afford any form of *agar*-wood. Mason speaks of it as Blinding Aloes, and by others it is called the Tiger's Milk Tree.

D.E.P., i., 282 7. Ground-nut.

ARACHIS HYPOGÆA, *Linn.*: *Fl. Br. Ind.*, ii., 161; Cooke, *Fl. Pres. Bomb.*, i., 408; *De Candolle, Orig. Cult. Plants* (Engl. ed.), 411; Mollison, *Textbook Ind. Agri.*, iii., 102; *Agri. Ledg.*, 1893, No. 15; 1899, No. 12, 147; 1900, No. 1; Burkill, *Kew Bull.*, 1901, 175–200; LEGUMINOSÆ. The Ground-nut, Earth-nut, Pea-nut, Monkey-nut, Pindar, Katjang, Pistache de terre, Manila-nut, Chinese-nut, and in the vernaculars of India (which for the most part are translations of one or other of the names mentioned), *mung-phali, bhui-mung, bhui-singh, bhui-chana, villáyoti-(biláti) mung, chini-badam, Manila-kotai, veru sangalu, mygleh, mibe,* etc. There are thus no Indian names that would imply an ancient knowledge of the plant.

Introduced into India.

This is undoubtedly, therefore, another of the very long list of plants introduced into India in comparatively recent times. There would seem little room for doubt that though nowadays extensively cultivated in all tropical countries it is originally a native of Brazil. But there would appear to have been successive and possibly independent efforts to introduce it into India. It may have come from China to Bengal (hence the name *Chini-badam*); from Manila to South India (*Manila-kotai*), and from Africa and very possibly direct from Brazil as well, to Western India.

Appearance in Europe.

History. It does not seem necessary to quote all the passages that support these conclusions. Perhaps one of the earliest direct references to this plant, as grown in India, occurs in Buchanan-Hamilton's *Travels through Mysore*, etc., published originally in 1800. In the *Report of South Arcot* (1850–1) mention is made of 4,000 acres being under the crop. The nut made its appearance in Europe as a commercial product about the year 1840.

Indian Trade.

The Indian modern trade may be said to date from a Resolution of the Government of India published in November 1877, and a subsequent Resolution of August 1879. In consequence of the replies to the latter, J. E. O'Conor wrote a report on *The Cultivation of Ground-nut in India* (*Journ. Agri.-Hort. Soc. Ind.*, 1879, n.s., vi., 87–98). After detailing the facts ascertained regarding the extent of cultivation and other useful and interesting particulars, he drew attention tersely to the present position and future prospects of the Indian foreign trade in the nut.

Early Shipments.

The exports were in 1878–9, 25,472 cwt., "or little more than 1 per cent. of the imports into France. The question now is, whether India should be content to leave France to draw all her supplies of this valuable food-stuff and commercial product from Africa or whether she should not enter actively into competition for at any rate a substantial portion of the trade" (*l.c.* 97).

Chief Publications.

Space cannot be afforded in this work to deal very fully with the subject of the ground-nut. It may, however, be useful to enumerate, in sequence of date, some of the more important publications in addition to those mentioned in the *Dictionary*. [*Cf.* Dymock, *Mat. Med. Western Ind.*, 1884, 674; Church, *Food-Grains of India*, 1886, 127; *Pharmacog. Ind.*, 1890, 494–6; Voelcker, *Journ. Roy. Agri. Soc.*, 3rd ser., 1892, iii., 727–30; Sabba Rao, *The Ground- Earth- or Pea-nut, Mad. Agri. Dept. Bull.*, 1893, No. 28; Robertson, *Journ. Roy. Agri. Soc.*, 3rd ser., 1893, iv., 648–51; *Imp. Inst. Handbook*, 1893; Handy, *Pea-nuts, their Culture and Uses, U.S. Dept. Agri. Farmer's Bull.*, 1895, No. 25; Batten, *Queensland Journ. Agri. Dept.*, 1899; *Trop. Agrist.*, June 1, 1900; Barber, *The Ground-Nut Crops near Panruti, S. Arcot, Mad. Agri. Dept. Bull.*, 1900, No. 38; Leather and Benson, *The Ground-Nut Crop, Rept. on Certain Anal. and Exper., Mad. Agri. Dept. Bull.*, 1900, No. 41; Leather, *Dept. Land Rec. and Agri. Mad.*, 1900; *Imp. Inst. Tech. Repts.*, 1903, 126, 130; *Ann. General Memo. Earth-Nut Crop Ind.* (issued by the Director-General of Statistics), 1899–1904; Freeman, *Ground-Nuts W. Ind., Imp. Dept. Agri.*, pamphl. ser., No. 25; *Rept. Disease of Ground-Nuts, Mad. Board Rev.*, June 1904, No. 615; Barber, *Sc. Rept. Dept. Agri. Mad.*, 1905–6; etc., etc.]

Cultivation.
Chief Centres of Production.

CULTIVATION.—Although grown here and there all over India as a garden and even an occasional field crop, it is only in Madras and Bombay that the pea-nut is produced on a commercial scale. The remarks that follow will, therefore, be restricted very largely to an abstract of the available particulars regarding these two Presidencies.

Madras Area.
Bombay Area.
Decline in Production.
Chief Districts.

Area.—In most provinces the area under the crop is not returned separately from other pulses or other oil-seeds, so that a complete statement cannot be furnished. O'Conor tells us that in 1879 there were in all India 112,000 acres under the crop, of which 70,350 acres were in Bombay and 34,630 acres in Madras. Ten years later (1889–90) Madras alone was returned as having had 279,355 acres, of which 185,876 were in South Arcot, the chief seat of South Indian production. From that date the popularity of the crop steadily declined up to 1897–8, from which date it improved. Omitting the last three figures, the areas in Madras were as follows:—258 in 1890–1; 201 in 1891–2; 226 in 1892–3; 247 in 1893–4; 226 in 1894–5; 243 in 1895–6; 157 in 1896–7; 94 in 1897–8; 116 in 1898–9; 102 in 1899–1900; 229 in 1900–1; 337 in 1901–2; 421 in 1902–3; 384 in 1903–4; 366 in 1904–5; 393 in 1905–6, and the estimate for 1906–7 shows the Madras area as 507,600 acres, while that of Bombay is only 93,800 acres. The explanation of this decline and subsequent expansion will be found below—viz. the improvement rapidly accomplished by the introduction of a new stock. The experience of Bombay (including its Native States, mainly Kolhapur) has been somewhat similar, except that production has not recovered. The acreage under the crop in 1891–2 stood at 145,468, and in the succeeding years, expressed in hundreds, was as follows:—142 in 1892–3; 184 in 1893–4; 159 in 1894–5; 164 in 1895–6; 148 in 1896–7; 120 in 1897–8; 101 in 1898–9; 71 in 1899–1900; 64 in 1900–1; 96 in 1901–2; 69 in 1902–3; 89 in 1903–4; 93 in 1904–5; and 95 in 1905–6. Bombay cultivation may be said to be confined to the Deccan and the Karnátak with Sholapur and Satara as the most important districts.

Varieties.
Edible and Oil-yielding.

Varieties and Races, also Deterioration of Stock.—From the early imported stock there had gradually developed certain races of the plant that within the past few years came to be spoken of collectively as the "Indigenous Variety." Some of the so-called indigenous races are grown purely and simply on garden soil and eaten as nuts, others are specially adapted for field cultivation and vary greatly in the amount of oil they contain. Although doubtless inferior, India thus possesses a series of races that correspond to the large edible forms produced in perfection in America, and to the special smaller oil-yielding nuts of Africa. In the *Madras Bulletin* (No. 37) mention is made

A Facile Theory.

Soil-exhaustion.

Percentage of Oil.

of a communication from the Madras Chamber of Commerce attributing the decline in the production of the nut to a deterioration in the quality of the Indian stock. In reference to that opinion, Sir William Thiselton-Dyer, then Director of the Royal Gardens, Kew, addressed the Under-Secretary of State for India on February 23, 1899. The following passages may here be given from that letter: "I may say at once that deterioration of seed is a facile theory which is continually advanced when the produce of a crop is disappointing. It is one in which I have very little belief. The real explanation of the falling off is to be found usually in the exhaustion of some constituent of the soil. Madras ground-nuts have long been known to be poorest in quality of any to be found in commerce. The percentage of oil in shelled kernels is given in the United States *Consular Report* (April 1, 1894, 683-9) as follows :—Senegal, 51 ; East African, 49 ; American, 42 ; Madras, 43. From these figures it does not appear that any advantage would arise from introducing American seed. As to Japan ground-nuts I have no information. The oil from the American seed again appears to command an inferior price to that of Africa."

Wood-ashes as Manure.

Food.

"The problem is one which should be taken up on an experimental farm. It is not improbable that want of potash is the cause of this diminished yield, if the diminution be a fact. Manuring with wood-ashes would be a simple means of testing this." "Formerly the cake or residue after the expression of the oil was only used for cattle food. It is now converted into various palatable forms of human food, the use of which has been tried with success in the German army."

Inquiry.

No Deterioration in Bombay.

The reference to American and Japanese seed was doubtless in consequence of the proposal to import such seed having been made in the Madras Government *Proceedings*. The above letter caused a searching and highly beneficial inquiry to be instituted in both Madras and Bombay. Opinions were called for from the District Officers of Madras Presidency, but the replies may be said to have manifested a remarkable agreement in favour of the theory of a deterioration of the Indian stock having actually taken place. Mollison, on the other hand, wrote: "I do not think that any positive deterioration in the seed of the Bombay crop can be proved. There is, however, perhaps good reason to join issue with the Madras Agricultural Department and test on Government Farms whether imported seed of the better varieties give better results than the indigenous seed. I should, however, do this in the first instance on a small scale." It has been shown by the areas of production, that quite as serious a decline, however, took place in Bombay as in Madras. It is probable, therefore, that the shrinkage in both Presidencies may have been due to the same causes, whatever these may have been.

New Seed Imported.

Revolution in Production.

Acting on the opinion of its local officers, the Madras Government imported various reputed races of seed, and private individuals seem to have done the same. The result was that the indigenous varieties were rapidly displaced, and it is believed at the present moment they hardly anywhere exist in the Madras area of field cultivation. Barber in his report (published 1890) says: "Two or three years ago something like a revolution had occurred in the introduction of a new variety called the Mauritius ground-nut. The suddenness and completeness of this change is worth considering." Barber accordingly gives particulars of the crops found by him on certain fields. He only came across four little pieces of land containing the indigenous plant, and these he did not think collectively could equal an acre in extent. He then continues: "The *ryots* of this neighbourhood have, therefore, changed their seed, and I believe that they have obtained a good variety and have thus greatly improved their position." In another passage Barber again returns to the subject: "There has recently," he says, "been a change of seed—a fact which is of undoubted importance in the checking of disease, if of no further advantage."

Experiments with various Seeds.

Madras Results.

Benson (*Bull.* No. 41) gives the results of the Madras Government experiments, as also of the French Government experiments at Pondicherry. These showed splendid results in Madras with the *Haut Saloum* variety from East Africa, and in Pondicherry with the *Senegal.* The returns of the Saidapet Farm were as follows:—Country, 271 lb.; Mauritius, 425 lb.; Japan, 427 lb.; Ruffisqul, 598 lb.; Sine, 884 lb.; Gambie, 1,021 lb.; Haut Saloum, 1,379 lb.; American large, 303 lb.; and small, 436 lb. per acre. The figures of the Pondicherry experiment from equal plots were as follows:—yield, 21 lb. from Bombay seed; 41 lb. from local seed; and 652 lb. from Senegal seed. Benson then concludes by explaining that the so-called Mauritius, now largely being grown in the Presidency, came in reality from Mozambique, though brought to India by a passenger from Mauritius. "That variety," he adds, "has given results on a par with the Senegal, but the seed contains a *resino-gommeuse* substance which, as it remains in suspension in the oil, delays the settling and gives a very pronounced taste of the groundnut to the oil." Mollison (*Textbook, l.c.* 104) says: "A good crop on suitable land liberally managed will, on an average, yield from 3,200 to to 3,500 lb. of unhusked nuts per acre. These figures apply only to good land. The proportion by weight of unhusked nuts to those with husk removed is as 4 to 3." "They are usually sold unhusked, and are worth from 30 to 45 lb. per rupee according to locality and season."

Bombay Experience.

Improvement in Production.

Poverty of Soil.

Exchange of Seed.

Edible Nut.

In response to the reputation of an inferior yield of oil from the Indian nut, Leather made an extensive series of analyses, the result being the discovery that the yield in the indigenous seed averages from 40 to 44 per cent. and that of the so-called Mauritius from 44 to 49 per cent. It would thus appear that India has not only secured a more prolific plant but one richer in oil by the importation of the Mozambique seed. As already indicated, an improvement in production has taken place, which must, to some extent, be the direct expression of the renewed popular favour of the crop. Of Indian agriculture, however, it would not be far from correct to affirm that the selfish systems pursued very often result in an unconscious retrograde selection, so that it may be believed degeneration of imported stock is an exceedingly frequent result. But it goes without saying that the continuous cultivation of the same plant with little manure and an imperfect rotation must produce a poverty of soil and a corresponding decline in the value of produce. Fresh supplies of seed or seed brought from a distance to the country or locality of cultivation, is in all branches of agriculture an admitted advantage. It remains to be seen how long the new seed will retain its superiority on the Indian soil and under Indian methods of cultivation. By way of concluding this paragraph, therefore, it may be added that there is little or nothing to prove that a decline in the oil-yielding property of the Indian stock had actually taken place. It was grown originally as an edible nut, and it is probable that no effort was made to improve the stock into an oil-yielding form, so that it was, doubtless, always inferior as an oil plant, just as the American plant is so, compared with the special oil forms of East Africa. Mr. E. Solly reported to the Royal Asiatic Society (Committee of Commerce and Agriculture) in 1838, that he found the Indian ground-nut to contain 45·5 per cent. of oil. O'Conor tells us that in 1878–9 the husked seed yielded from 33 to 50 per cent. of oil. It thus seems highly probable that the present average, ascertained by Leather, may have prevailed ever since India participated in the world's supply of the nut. But within recent years the Indian plant has been subject to several diseases, and may have become in consequence less profitable to the cultivators than was formerly the case.

Less Popular.

Diseases.

Diseases and Pests.—In *The Agricultural Journal of India* (i., pt. ii., 170–1) there will be found a short note by C. A. Barber on this subject. "The pests attacking ground-nut are comparatively few, the principal ones being '*Surul*' or '*Mudupuchi*' and '*Tikka*.' The latter is a fungoid disease which is not at present very serious in this part of India and apparently prevails in damp, close weather. *Surul* on the other hand is universally present and does great damage. The word '*Surul*' means a '*curling*,' and is dependent on the habit of the insect of burrowing inside the tissues of the leaves, which curl up and get distorted. The chrysalis is formed in a fold of the leaf. The insect is a minute dark moth (***Anacampsis nextoria***, *Meyr.*) of very active habits and is probably nocturnal. On walking over the fields a constant shower of disturbed insects may be seen that quickly seek shelter under the neighbouring leaves. The walls of bungalows in the neighbourhood are sometimes blackened at night by millions of the moths attracted by the bright lights.

"The *Surul puchi* appears to prefer laying one egg in each leaflet, which speedily turns brown and withers. In a bad attack the whole field assumes a blackened or blasted appearance. As is the case with most pests of this class, showers of rain are most beneficial, while hot sun and dry air lead to rapid increase, whether in dry or irrigated crops.

"From the internal working of the caterpillar it is doubtful whether spraying will be of much use, but, on the other hand, it seems probable that light traps may help in destroying the moths at night."

Soils.

Soils.—The ground-nut requires a sandy loam, light and porous, with plenty of lime, free subsoil drainage and a liberal supply of water. In Madras, according to C. K. Sabba Rao, the best soil is ash-coloured, absorptive and fairly retentive of moisture. The nut, however, is most generally grown on the more prevalent red sandy loams, but the opinion prevails that the darker the soil the darker the nut and the less desirable for seed purposes. Mr. Handy urges this same fact, namely that a light-coloured soil gives a light-coloured pod and thus improves the selling value as an article of food, though, he adds, "equally sound and well-flavoured nuts may be produced on other soils." Sabba Rao further observes that salt soils are unsuited, though stony soils rich in sand (if well manured) may yield a highly profitable return, while clayey soils are quite unsuited. In South Arcot, he tells us that the ground-nut had displaced indigo, since it is more profitable; on the soil on which the one crop flourishes the other may be equally successfully grown. Mollison, speaking of Bombay, observes that although raised on black land it delights in a good loam. But he adds that a heavy crop cannot be got without manuring and careful tillage.

Light-coloured Soils.

Black Land.

Rotation.

Rotation of Crops.—Sabba Rao remarks that the *raiyats* are unanimously of opinion that ground-nut is an exhausting crop and that it cannot be cultivated uninterruptedly without the liberal use of manure. The rotation, which they observe, is with the second crop off the same field within the year, a rest being given every fourth or fifth year. "In the majority of cases, in South Arcot, the crop is sown amongst a standing crop of *kambu* (***Pennisetum typhoideum***), *rági* (***Eleusine Coracana***) or other crop when the latter is being hand-hoed. In places where the crop has been recently introduced and plenty of good manure is available, it is cultivated either year after year on the same land, or only with an intervening crop at intervals of 4 or 5 years, whilst in some villages of the Shivali taluk it is cultivated without intermission. In the neighbourhood of Panruti . . . the crop is changed once in 4 or 5 years." Sabba Rao next gives particulars of the various crops with which ground-nut may be rotated and

Madras Method.

Mixed Crops.

Rotation.

the reasons for and against each, and adds that the most popular rotation is with the cereal *varagu* (***Panicum miliaceum***). Barber recently re-investigated the question of rotation of ground-nuts with other crops and came to the conclusion "that the charge of continuous cropping was well-founded. The answer usually given to general inquiries on the subject was that a rest of one year was allowed in every 4 or 5." "The fields may be said to have little rest. Several crops are usually taken off in the year, of which ground-nuts form one." "Of scientific rotation it may safely be asserted, as regards ground-nuts, there is none, although the interval of rest allowed to the land shows that the *ryot* is aware of its advantage." Barber thus views rotation from a different standpoint to that of the Indian cultivator, and by most persons his views would be upheld.

No Rotation.

Bombay Method.

Mollison, speaking of the rotation pursued in Bombay, says the production of ground-nut is undertaken by well-to-do cultivators, and is an indication of prosperity and easy circumstances. It is often rotated with sugar-cane and chillies, and is occasionally taken where potatoes, onions, and *brinjals* (***Solanum Melongena***) are grown. In the garden land of Surat, where *chiclo* (a sedge) is a troublesome weed, the growth of ground-nut helps to suppress it, and the thorough digging which the soil gets in removing the nut is very beneficial. Among garden crops ground-nut occupies the important position which gram holds among dry crops.

Manure.

Silt.

Manure.—Sabba Rao observes that the best manure appears to be the silt deposit of tanks, and so highly is this valued that the cultivators carry silt from great distances and even pay high prices for the privilege of removing it. In South Arcot the fields are so manured once in 4 years with from 50 to 100 cartloads per acre. The silt from the Perumal tank (that most in use in South Arcot) has been found to contain about 22 per cent. of lime and nearly 70 per cent. of sand. Lime is fully recognised as a valuable manure for the crop. [*Cf. Saidapet Farm Manual.*] Ashes are also reckoned as very good manure for ground-nut, more especially on poor, sandy soils. So important is this that ashes also are carried great distances, even by rail, to the ground-nut area. Ashes are in fact applied every year, sometimes at the rate of 30 cart-loads an acre. With regard to Thiselton-Dyer's recommendation to test the value of wood-ashes as a manure, it may be remarked that Leather made a special examination of certain soils in South Arcot, commonly under ground-nut. He found them all very deficient in lime. Four contained too little phosphate; five were low in nitrogen, and only one showed a defect in potash. Mollison remarks on the subject of manures for ground-nuts that sheep or goat manure, applied either by folding the flock on the field or otherwise, is considered specially suitable, but, failing this, ordinary farm-yard manure should be applied in considerable quantity. Deep ploughing and thorough pulverisation of the soil before sowing help the crop materially.

Lime.

Sheep and Goat Manure.

Madras Method.

Preparation of Land and Seasons of Sowing and Reaping.—After the remarks already made on soils, rotation, etc., it is hardly necessary to do more than observe that ordinary methods of tillage usually suffice. About 90 lb. of seed per acre will be sufficient for sowings made up to the middle of August, but later on about 112 lb. are required since the plant does not grow so luxuriantly. The crop is sown thickly since the bulk of the pods are borne within a few inches around the central stem.

Seed to the Acre.

Hoeing.

Watering.

The crop is generally hand-hoed twice, about fifteen men per acre being required each time. The bullock hoe is not used owing to the injury done by it to the crop. In normal seasons ground-nuts, sown under irrigation, are watered twice a week during the last two months. While being watered it is customary to weed the plots, and in some cases the plants are lightly trodden under foot with the object of bringing them into better contact with the soil. On unirrigated land the crop is sown any time between the middle of June and the middle of August; on irrigated land from the middle of August to the middle of September. The latest possible sowings are from September 30 to October 15, viz. in Chingleput and North Arcot. There would thus appear to be two areas or conditions—an early and a late. The normal dates of sowing for the former

Unirrigated Crop.

Irrigated Crop.

would appear to be from July 15 to August 15, and for the latter from August 1 to September 15.

Duration of Crop in Soil.

Market Seasons.

The duration of the crop in the soil seems to vary considerably. The crop sown on irrigated land in South Arcot normally on July 10 comes into season about October 10, having occupied the soil for only three months. Again, the crops sown normally on June 15 in the Bhavani and Cauvery valleys are not mature until January 15, and have thus occupied the soil for seven months. Usually the crop occupies the soil a little over five months, and thus for the early districts (such as South Arcot) it comes into market from January 15 to February 15 and for the later districts (Chingleput and North Arcot) from February 1 to March 15. As a rule, however, in the districts of late sowing the crop occupies the soil for a slightly shorter period, and thus comes into market approximately at the same time as the other sowings.

Bombay Method.

Two Crops.

Ploughing.

Weeding.

Of Bombay Mollison observes that the ground-nut is usually a *kharíf* (rain) crop, sown as soon as the previously prepared soil has been sufficiently moistened by the first fall of rain in June ; but in the Deccan it is also grown as a *rabi* (winter) irrigated crop. The monsoon crop occupies the soil six to seven months, and in the absence of rain the land must be kept moist artificially. It is usual to give two to four waterings during the last two or three months. The seed is ordinarily sown between monsoon showers, when the land is dry enough to be worked by a plough. The crop should be weeded at least twice. As soon as it shades the ground, no further attention, except watering, is required. The crop is harvested likes potatoes, sometimes with a plough, but more often the field is dug over by hand with a Native pick. A cultivator collects a regular army of workers, and usually pays in kind. In order to expedite the digging the haulms or vines are previously reaped and removed. These form an esteemed fodder.

Bombay Seasons.

The returns of sowing and reaping furnished by the authorities regarding the Bombay Presidency show the crop to be slightly earlier in Bombay than in Madras. The earliest sowings take place on June 1 and the latest on July 31. Of the Bombay districts Poona and Sholapur sow, as a rule, about fifteen days later than the other districts. The period of occupancy of soil varies considerably ; the maximum duration is eight months in Belgaum, where the crop is normally sown on June 10 and reaped usually about February 10. In Ahmednagar it is reaped a month sooner, having occupied the soil for seven months. The shortest duration is four and a half months in Poona, where the crop, sown on June 15 (normally) is reaped on November 1. In other districts the crop occupies the soil a little over five months, and as Satara and Sholapur are the most important producing districts it may be added that the Bombay crop comes into season in November, and thus on an average six weeks before the chief Madras crop. This is therefore a fact of considerable importance which the foreign buyers of Indian nuts should bear in mind.

Centres of Trade.

Oil.

TRADE.*—*Foreign Trade.—It has already been fully demonstrated that the area of production in India has been vastly extended and the condition and location of the trade exactly reversed since O'Conor's report of 1879. The greatest area of production is now in South India, and moreover there has grown up in Madras a considerable traffic in the manufacture and export of the oil. In other words, an increased local consumption would seem to be gradually lessening the amount available for foreign transactions. It would thus seem that to some extent at least this may account for the outcry regarding a decline in the Madras traffic. It is more than probable, however, that the prevalence of disease in the crop and the exceptionally unfavourable seasons of 1897–8 and 1899 (during which the rains failed at the sowing season and the prices of foodstuffs rose on account of famine) directly decreased the available area of production. This state of affairs was not peculiar to the earth-nut but marked the traffic in all other oil-seeds. Such a condition might easily enough be supposed to accentuate the knowledge, if such existed, of the inferiority of the Indian as compared with certain other well-known commercial oil-yielding stocks, until the opinion might have been formed that a deterioration of the Indian nut had occurred. While such deterioration may have been taking place, it is a matter of history that the increasing imports into Europe of improved cotton-seed oil from the United States and India gradually displaced ground-nut and other oils from some of their markets and thus tended to lower the prices offered for them. Be the explanation what it may, the new seed, presently being eagerly sought after by the Indian cultivators, has aready given tokens of being much superior to the old stock, and, as a possible result of this as also a consequence of the return of more prosperous seasons, the area of production has greatly increased.

Famine.

Effect of Cotton-seed Oil.

Foreign Exports.

Exports.—The following figures may here be given in manifestation of the past and present Foreign Exports of Ground-nuts from India :—In 1894–5 the total exports were 2,267,222 cwt., of which Bombay contributed 1,598,387 cwt. Taking the subsequent years and for convenience *omitting the last three figures*, the corresponding trade returns were for 1895–6, total 1,118 cwt. and Bombay's share 796 cwt. ; for 1896–7 they stood at 486 and 238 cwt. ; for 1897–8 at 44 and 19 cwt. ; for 1898–9 at 87 and 76 cwt. ; for 1899–1900 at 155 and 23 cwt. ; for 1900–1 at 232 and 29 cwt. ; for 1901–2 at 1,085 and 98 cwt. ; 1902–3 at 1,035 and 52 cwt. ; 1903–4 at 1,921 and 91 cwt. ; 1904–5 at 1,674 and 42 cwt. ; 1905–6 at 1,374 and 149 cwt. ; and 1906–7 at 1,725 and 130 cwt. It will thus be observed that a serious drop in the trade took place in 1896–7 and became accentuated in 1897–8, since which date a revival has gradually set in, but mainly in the Madras supply, the Bombay exports being now only a small proportion of the former magnitude. In 1906–7, however, the Madras supply decreased to 1,350,096 cwt. from 1,827,243 cwt. (in 1903–4), while the Bombay supply increased from 42,408 cwt. to 130,356 cwt.

Internal Traffic.

Internal Traffic.—The returns of the traffic by rail and river show that the chief movement is from the Presidency of Madras into its port towns and thus to meet the foreign exports. Of the total amount carried by these routes in 1906–7 (viz. 1,733,123 cwt.) Madras ports alone took 1,476,198 cwt.

Oil.

Hot and Cold Methods of Expression.

Trade in Oil and Cake.—The oil may be obtained by cold expression or by moderate heat. The former process affords the best oil but in smaller quantity than the latter. The cold-pressed oil is almost colourless, has an agreeably faint odour and a taste not unlike that of olive oil. That obtained by the hot process is dark yellow and has a more or less disagreeable taste and smell. Although the oil does not turn rancid so quickly as most Indian oils, on exposure it slowly thickens and then becomes rancid. It is a non-drying oil, the best qualities of which have a sp. gr. of about 0·918 at 15° C. when fresh, and

Uses.

Medicine and Food.

European Trade.

0·920 when old. It becomes turbid at 3° C., concretes at 3° C., and hardens at −7° C. As an illuminating oil it is now recognised as having but a feeble power, and its chief use is therefore in soap-making and as a lubricant. It is also much employed by perfumers in the preparation of pomades, cold creams, etc. The finer qualities are, however, used both in MEDICINE and as an article of FOOD, and there can be little doubt that large quantities are annually passed off as Olive oil and are made into a form of butter employed in cookery. The chief centre of this oil industry may be said to be at Marseilles, though it is also produced at London, Hamburg, Berlin, etc.

Indian Oil Trade.

Pondicherry *versus* Madras Ports.

Formerly the seat of the Indian ground-nut oil trade was Pondicherry. In 1894, however, a change took place and the traffic migrated to Madras ports, more especially the port of Cuddalore. In 1890–1 the total exports (coastwise and Foreign)' from Pondicherry are said to have been 762,195 gallons and from Madras ports 41,275 gallons. In 1893–4 the corresponding figures were 860,800 gallons and 8,717 gallons, but in 1894–5 they stood at 165,858 gallons from Pondicherry and 567,375 gallons from Madras ports, while in 1895–6 the coastwise exports from Madras were 690,134 gallons, mostly consigned to Burma. Steadily this change continued until the exports from the French port had been entirely discontinued. A similar migration of the trade in ground-nuts from Pondicherry also took place.

Total Exports in the Oil.

Coastwise Traffic.

Turning now to consider the total traffic of India in this oil, the total foreign exports for the last eight years were 1898–9, 27,859 gallons; 1899–1900, 53,261 gallons; 1900–1, 40,357 gallons; 1901–2, 73,079 gallons; 1902–3, 84,785 gallons; 1903–4, 50,603 gallons; 1904–5, 48,582 gallons; 1905–6, 7,814 gallons; and 1906–7, 16,608 gallons. The total coastwise exports from India (not Madras alone as above reviewed) during the corresponding periods were in 1898–9, 544,572 gallons; in 1899–1900, 761,584 gallons; in 1900–1, 1,585,964 gallons; in 1901–2, 2,159,843 gallons; in 1902–3, 1,610,975 gallons; in 1903–4, 1,761,898 gallons; in 1904–5, 1,469,769 gallons; and in 1905–6, 2,472,334 gallons. Of these amounts on an average 70 to 80 per cent. go from Madras to Burma, while the foreign exports in the oil go mainly from Madras and Bengal and are consigned to Mauritius, Natal and the Straits Settlements.

Native Oil Mills.

Oilcake.

Oil Mills.—It is significant that the bulk of the Indian manufacture of this oil should be in the hands of the owners of ordinary Native pestle-and-mortar-pattern rotary mills. At Valavapur there are said to be 700 such mills, at Panruti 200 mills, and at Pondicherry there were formerly 200 mills. Mills of the European pattern were tried both at Pondicherry and Cuddalore, but it was found they could not compete successfully with the Native mills. The cake from the European mills was too dry, powdery and wanting in oil, hence everywhere rejected. This is all the more significant since so very economically are the oil mills worked at Marseilles that ground-nut oil is cheaper in France than in India—a circumstance perhaps to some extent due to the fact that African seed is very much richer than Indian. It is commonly estimated, moreover, that 1 cwt. of dry kernels will yield about 5 gallons of oil. The seed produced on unirrigated is more oily than that raised on irrigated land. Formerly it was customary to read of the seed of Tanjore and Shiyoli being richer in oil than that of any of the other districts of Madras. It remains to be seen if the same will be true of the Mozambique seed now being cultivated or if the new seed will preserve a uniform quality throughout the Presidency.

Bengal.

Recently mills have been opened in Calcutta and elsewhere in Bengal for the manufacture of this oil. Already these new mills have had the effect of checking the imports of the oil that formerly came from Pondicherry and Madras, and they have given birth instead to a large import traffic in the nuts. One of the chief markets for the South Indian groundnut oil has been the supply required by Burma. From recent correspondence hope is entertained of the Shan States being able to meet the Burma demand. For information regarding the CHEMISTRY of the oil and of the oilcake and their values as articles of food, as also the medicinal and industrial uses of these and other products of the ground-nut, the reader is referred to *The Agricultural Ledger* (1893, No. 15) and to the *Kew Bulletin* (1901, 194), more especially the particulars given regarding the pea-nut flour and biscuits. It seems probable that as an article of food during military operations, special preparations of the pea-nut may have a great future. For microscopic examination of pea-nut cake consult Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 387–91).

Supply from the Shan States.
Chemistry.

ARECA CATECHU, *Linn.*: *Fl. Br. Ind.*, vi., 405–6; Gamble, *Man. Ind. Timbs.*, 726; Talbot, *List. Trees, etc.*, 1902, 339; *Rec. Bot. Surv. Ind.*, ii., 347; *Agri. Ledg.*, 1900, No. 4; 1901, No. 8; Mollison, *Textbook Ind. Agri.*, iii., 256–62; Mukerji, *Handbook Ind. Agri.*, 433–5; PALMÆ.

D.E.P., i., 291-301. Betel-nut Palm.

Habitat.

Habitat.—So much might be written regarding this nut that it is difficult to make a selection of the particulars likely to prove of greatest value from the commercial and industrial standpoint. It is cultivated exclusively within the moist tropical tracts that fringe the coast of India and practically within a belt of land that does not extend inland for more than 200 miles. It rarely ascends to altitudes of 3,000 feet and gradually disappears, even from the littoral area, as localities are entered where the duration of the dry hot months equals or exceeds the monsoons. Usually it is seen as a garden plant, two or three or a dozen palms at most being found around the huts of the more prosperous and industrious. But occasionally, and in certain localities, especially of Southern and Western India (Malabar) and of Burma, where the soil and climate may be exceptionally favourable, it is grown in special gardens along with cocoa-nut, plantain, orange, mango, etc., and either with or without the *pán*—*piper betle*—climbing on the palm-stems. Lastly in Eastern and Northern Bengal and some portions of Assam its cultivation has assumed still greater dimensions. In certain districts of these provinces regular plantations of 5 to 20 or even 100 acres in extent occur (exclusively of betel-nuts) and at such frequent intervals that they might almost be said to constitute a distinct agricultural feature scarcely less important than the combined crops raised on the intervening portions of the country.

Garden Plant.
Cultivation in Bengal.
Field Cultivation.

History.—This cultivated palm is met with throughout the hot damp regions of Asia and the Malay Islands. It is a masticatory of great antiquity with all Asiatic races, best known as *Betel-nut, suvaka, puga, kramuka* (Sansk.), *fufal* (Arab.), a corruption of *pupal* (Pers.), a word cognate with *kubara* (Sansk.). By these and other names was originally meant *Piper Betle* leaf—the *Pán*—though subsequently these and many other names were appropriated to the nut or to the special preparation of leaf, nut, lime and spices ready to be chewn. This was first designated *bira* (*vira*) *viti* in Sanskrit but ultimately became *pán*, the *pawn* or *pan-sapari* of modern writers. The nut is symbolical of festivity; it is accordingly a fit offering for the gods, and is an essential at the betrothal ceremony

Ancient Names.

From the most ancient times the presentation of *pán* has been the polite termination of ceremonial visits, hence the expression *bira-dena*—the dismissal. The name Betel or Betle is Malayan in origin and simply means "a leaf," and came to English through the Portuguese Betre. The best-known vernacular names for the nut are—*supári, hopári, gua, gaya, kasaile, mari, tambul, poka-vaka, oka, kamugu, adike, kunsi,* etc.

It would seem that the earliest historic reference by a European to the habit of chewing betel-nut occurs in the writings of Marco Polo (1298 A.D.). "All the

First mentioned by a European.

Arab Authors.

people," he wrote, "have the habit of keeping in the mouth a certain leaf called *tembul*." Subsequently Vasco da Gama (in 1498), Varthéma (in 1510), Barbosa (in 1516), Garcia de Orta (in 1563), Acosta (1578, 94), Abul Fazl (in 1590), Linschoten (in 1598), François Pyrard (1601), Roe (in 1615), Jacobus Bontius (1629), Bernier (1656–68), Boym (1656), Vincenzo Maria (1672), Tavernier (1676), and Catchpoole (1703) [*cf.* Yule, *Diary of William Hedges*, ii., 331], all give similar accounts. Adams in his translation of *Paulus Ægineta* refers to the betel-nut as introduced to Materia Medica by the Arabs. He quotes amongst others the passages referring to it from Avicenna, Haly-Abbas, Ebn Baithar, Elmasudi, Serapion and others. Ebn Baithar says that it is the fruit of a palm, and observes that it is a gentle purgative, makes the breath fragrant, is a cordial and strengthens the gums and teeth. Linschoten remarks that "The Indians goe continually in the streets and waies with *Bettele* or *Bettre* and other mixtures in their hands, chawing, especially when they go to speake with any man, or come before a great lord." Abul Fazl apparently never saw the palm growing, since he likens it to a cypress tree that in the wind sways till it touches the ground. This circumstance may be accepted as showing that from very ancient times, as at the present day, the nut has been carried to regions remote from the areas of its production. Numerous publications have appeared within the past century that deal with the betel-nut, as met with in India. The following selection in amplification of the references in the *Dictionary*, may be mentioned by way of concluding this very brief historic sketch:—Valentia, *Voy. and Travels Ind.*, 1802–6, i., 101; Buchanan-Hamilton, *Journ. through Mysore and Coorg, etc.*, 1807; also *Stat. Acc. Dinaj.*, 1809, 150; *As. Journ.*, 1819; Roxburgh, *Fl. Ind.*, 1832; Taylor, *Topog. Stat. Dacca*, 1840; Honigberger, *Thirty-five Years in the East*, 1852; Elliot, *Fl. Andh.*, 1859; Mason, *Burma and Its People*, 1860; Baden Powell, *Pb. Prod.*, 1868; Jackson, *Notes on the Areca Palm*, *Pharm. Journ.*, 1874, 3rd ser., iv., 689; De Candolle, *Orig. Cult. Plants*, 1884, 427; *Pharmacog. Ind.*, 1893, iii., 522–32; Cameron, *For. Trees Mysore and Coorg*, 1894; Duovuri Balakrishna Murti, *Lecture Cult. Areca-nut in Godavari Dist.*, *Ind. Agri.*, Feb. 1899; Collins, *Cult. Betel-nut in Toungoo Dist.*, *Burma*, 1900; *Journ. Soc. Chem. Indust.*, 1901; *Joret, Les Pl. dans L'Antiq.*, 1904, ii., 298; Cunningham, *Plagues and Pleasures of Life*, *Beng.*, 1907, 335–51; etc., etc.

Bengal.

Mandar and Betel Groves.

Planting Shade-trees.

Seasons of Sowing.

Transplanting Season.

Cultivation in Bengal.

CULTIVATION.—Propagation in Bengal.—In my report on *A Plague in the Betel-nut Palms of Bengal* (*Agri. Ledg.*, *l.c.*) much useful information will be found on these subjects. In the districts of Backerganj and Noakhali the Areca palms are planted in groves of *mandar* (*Erythrina indica*). These enrich the soil, afford shade from the intense heat and protection from sudden wind storms. Branches of the *mandar*, some 6 feet in length, are planted in rows, 12 to 15 feet apart each way. The planting is done in February to April, and from 2 to 6 years later these plantations are ready for the seedling palms. The betel-nuts are sown in October or November, the seeds being deposited 4 to 5 inches apart, and the nurseries are either close to the homesteads in shady places, or, if conveniently situated, they are made in the *mandar* groves themselves. The transplanting is usually done after 2 years, sometimes 3 or 4 years. For high lands the seedlings are transplanted in July, for low lands in February or April. In the first transplanting the betel-nuts are placed equi-distant from the *mandar* trees and thus 12 to 15 feet apart. But a second regular transplanting takes place when the first have come into bearing. Before this is done the *mandar* trees are cut down or only a fringe left around the circumference of the grove. The betel-nuts in a fully planted grove are thus about 6 to 7 feet apart each way. A certain amount of irregular planting takes place, however, as vacancies occur, and in selfishly conducted plantations the trees may be found here and there not more than 2 or 3 feet apart. It is probable that there is a certain amount of self-sowing, as it is not usual to find two or three trees growing in a clump so close to each other that they could not be healthy. In most plantations also a distinct percentage of cocoa-nuts are interplanted among the betel-nuts, so that an old plantation in many cases has lost all its original regularity and becomes a dense jungle of palms with only a winding footpath leading to the owner's house. This generally stands on the bank of a tank and near the middle of the holding.

Seasons of Flowering and Fruiting.

The seasons of flowering and fruiting may be said to be distributed throughout the year. The flowers that form in January will ripen fruit in October; the flowers formed in March will fruit in December and January. The harvesting period is from October to the beginning or middle of January, but occasionally the new flowers may begin to form in December or January on trees from which last year's fruits have not been collected.

Duration or Possible Age.

If a few trees are planted near villages, but not in regular groves, the betel-nut may fruit when it is only 6 or 7 years of age. In plantations they rarely fruit before the tenth or twelfth year. The trees subsequently put out in the plantation (just as the first set begins to flower) do not come into bearing for 20 years. There is no third planting except, as already stated, to fill up vacancies. Land formerly covered with betel-nuts, if re-planted with them, even after a rest of several years, in the form of *mandar* groves, does not, as a rule, yield until the palms are 20 years old. It will thus be seen that it takes at least 30 years before a betel-nut plantation comes into full bearing. The fruiting life of a tree may be put at from 30 to 50 or 60 years after maturity, and the total life of the tree might thus be stated at from 60 to 100 years.

Soil.

The soil of the Bengal plantations is the ordinary grey sandy loam on which rice is grown. Occasionally the plantations are surrounded by a ditch and wall made of the soil thrown up from the ditch, but this appears to be more intended for protection than drainage. More inland, in the districts of Tippera, Dacca, Sylhet, Goalpara and Rangpur, the palm is grown on considerably higher land, and usually as special gardens or avenues in gardens, or along the high banks of the streams. In Northern Bengal and Assam the *pán* leaf is very often trained to grow on the Areca palm stems, so that the two industries are combined, while in the great nut-producing districts of the Sundribans the betel-leaf is never or very rarely grown in the nut plantations. In the lower portions of Sylhet and Cachar, on the other hand, betel-palm groves and pepper betel-leaf houses are very characteristic features of the river-banks. Taylor informs us that the average number of trees to a *bigha* in the Dacca district (two-thirds of an acre approximately) would be about 700, but he adds the palm is usually planted around gardens and huts and not in solid clumps.

No drainage.

Betel-leaf and Nut Gardens.

Bombay.

Bombay Presidency.—The betel-nut may be said to be chiefly grown along the coast from Kolaba, Thana and Kanara to Goa. Interesting particulars will be found in the Gazetteers of these districts and more recently in Mollison's special *Report on the Betel-nut, Pepper and Cardamom Gardens of Kanara*, as also in his *Textbook of Agriculture* (*l.c.* 257–8). He there tells us that the Areca is cultivated chiefly by Haviks—a race of cultivators supposed to have come originally from Mysore. "It does not matter much," he writes, "whether the soil is naturally fertile or not, because the yield of the crops grown is mostly affected by the quantity and quality of manure directly applied. . . . In many gardens irrigation is not required even in the hot weather. At this time a trickling stream, fed from natural springs, may be seen running along the main channels or a

Soil.

Nurseries.
Selection of Seed.
Planting Season.
Manure.

perennial *nála* passes by the main channels through the garden. The soil is thus kept continuously moist." "The palms are raised in seed-beds and are once transplanted before they are planted out permanently. The first seed-bed is carefully prepared, the soil is dug, broken fine and mixed with leaf-mould. Fully matured nuts from old trees are specially selected for planting. These are planted about 9 inches apart in April. The seed-bed should be kept thoroughly moist. The shoots appear in June. The seedlings are transplanted in October into any moist place in the garden or along the watercourses about two feet apart and remain until permanently transplanted. This permanent transplantation is usually done towards the end of the rains. In the following March the trees are manured with leaf manure and the manure is covered with fresh-cut branchwood which is partially withered but which retains the leaves. The object of placing a layer of small branches above the manure is to break the force of heavy rain."

Bearing Period.
Yield.

"The betel trees are manured as described every second year and come into bearing in ten years or so. The plantains are maintained for some years after the betel-palms are permanently planted, but in time are removed and cardamoms planted between the palms, and on the stems of the latter pepper-vines are trained. Betel trees are known to fruit freely for 30 or 40 years, and there is a popular belief that they are sometimes profitable much longer. On an average each tree has two bunches of fruit, sometimes three or four. But two good bunches yield as much as three or four inferior ones. The size of the bunch depends upon the manure used and upon the rainfall. A good bunch gives 200 to 300 nuts and a specially good one about 400. With unfavourable rain or cloudy weather in April or May many of the young nuts fall off and a smaller number of nuts on each bunch reach maturity. The trees produce flowers in March and April and the nuts are ripe in November or December, but to some extent the trees produce flowers and fruit out of season" (*l.c.* 259).

Artificial Hoods.
Pass from Tree to Tree.

The flower spathes and leaf-sheaths are "valuable products in the garden economy. They are used to provide hoods for protecting the branches of betel-nuts from the rain. If unprotected the nuts rot. Two sheaths are used to make one hood. The hoods are made and tied on by professionals who come from Mysore territory and below the Ghats. A good workman can make 250 hoods per day and is paid Rs. 2 per 1,000. This operation and tying them on costs at contract rates Rs. 10 to 12 per 1,000 bunches and two meals per day. The men do not ascend and descend each tree. When once they have climbed up, by means of slight exertion they swing the tree and deftly catch hold of another and rarely descend to the ground for hours. These expert climbers also gather the fruit by cutting the bunches from the stem, getting Rs. 4 per 1,000 bunches and three meals per day" (*l.c.* 260).

South India.
Mysore.
Cultivation in Madras.
Revenue.
Best Gardens in Malnad.

South India.—A good deal has been written on the subject of the special cultivation pursued in Mysore. Cameron (*For. Trees, l.c.* 324–6) practically reprints the account given in *The Mysore Gazetteer* when he says:—"Areca-nut gardens are a profitable source of income both to the cultivator and the State, the latter deriving a large revenue from a *halut* or custom duty levied upon the nut. The finest betel gardens are situated on the confines of the Malnad where there is a rich soil and plenty of water." "It is necessary, during the rainy season, however, to drain off superfluous water by means of open

Distance apart. **Yield.**

ditches placed at intervals between the rows of trees, for although the areca requires a perennial supply of moisture at no great depth in the subsoil, it is keenly susceptible of being waterlogged." "In topes exclusively apportioned to the areca-nut, the planting is mostly too close; 1,200 to 1,500 trees being allotted to the acre, exclusive of the banana trees." "A full-grown tree is calculated to produce 250 to 300 nuts annually."

Profitable. **Selection of Seed.** **Harvest.**

Mr. D. B. Murti, in his Lecture on the Cultivation of Betel-nut in the Godavari district, says a man owning a plantation of 3 acres is considered rich. The plantations contain mangoes, plantains, cocoa-nuts, jack-fruit, oranges, pomegranates, and these form a fringe around and also lines within, but areca-nuts are planted 10 to 12 years after the rows of other fruit trees have been established. Seed-nuts are selected specially from trees over 50 years of age because these form few but exceptionally large nuts. It is believed that such nuts ensure timely sprouting and steady growth of the future tree. The details of the nursery, of the transplanting, etc., followed in Godavari are similar to those already fully discussed. The harvest season is generally in the months of August, September and the first half of October.

Cultivation in Burma. **Locality.**

Burma.—Mr. G. G. Collins has recently published the following brief account of the cultivation of Betel-nuts in Toungoo:—"The Toungoo district is noted for its cultivation of and trade in the betel-palm. This is confined almost entirely to the Karen tracts lying in the Kanni (Leitho), Tantabin, Kyaukkyi and Shwegyin townships east of the Sittang river."

Yield. **Price.**

"The gardens are formed particularly on the lower slopes of the hills which form the eastern boundary of the district and from which run the numerous streams that drain to the Sittang. The cultivated area covers at intervals a course of some 200 miles from North to South. The produce of the trees varies with the locality; a fair average may be 100 per tree, but as many as 400 to 600 nuts have been obtained from one palm." "The cultivators of the betel-palm also grow oranges, many to a large extent, and the trade in both products in this district is very large. The price of the betel-nut at the gardens after drying varies from Rs. 80 to Rs. 100, and at the market town from Rs. 100 to Rs. 140 per 100 viss (viss = 3·65 lb.).

Diseases and Pests.

Fungal. **Mysore.** **Black Rot.** **Moisture.**

Diseases and Pests.—It may have been inferred that in the chief Indian area of production, viz. the Gangetic delta, the plant is cultivated on flat interfluvial tracts very little raised above inundation level, and has practically no labour bestowed on it during the half century or more that it continues to yield fruit. In other parts of India the palm is grown under a high state of cultivation with much attention and money devoted to it. These two extremes—utter neglect and careful treatment—should manifest, and perhaps naturally, widely different conditions of disease. Butler, in a paper on *Some Diseases of Palms* (*Agri. Journ. Ind.*, i., pt. iv., 299–310), observes that fungus diseases are fortunately rare though a few have appeared in recent years, each apparently confined to a particular part of the country. He then gives details of the diseases found on the betel-nut palms of the Malnad district of Mysore and of Sylhet in Eastern Bengal. It would appear that in the former locality a fungal disease is known as *kole roga* or black rot, but that "up to the present it has not been found elsewhere and, as it does not appear to have extended much during the time it has been observed, it is probably favoured by the special climatic conditions of the locality where it occurs." Butler is of opinion that the disease in question is caused by a fungus of the genus ***Phytophthora***. The reader should consult the original paper for all necessary details. The practical aspects may be here summarised. The *sporangia* require to fall into water to ensure their full propagation, and hence the spread of the disease is closely dependent on conditions of moisture and rainfall. The disease originates on the flowering and

Protection.

fruiting inflorescence, and for its growth it is necessary that moisture should exist at that period. He accordingly recommends steps being taken to secure a change in the period of harvest. The late crop of former years he regards as having been beneficial, and may be obtained by departures in the method of cultivation. So also improvements in the nature of the covers presently used to protect the inflorescence, he views as very desirable. Covers that leak, he adds, are likely to be more injurious than none at all.

Sylhet.

Speaking of the Sylhet disease, he says that the general symptoms are the same as those in Mysore *kole roga*, namely, the dropping of the nuts before maturity. Gradually the swollen green part below the leaves is seen to diminish in size. Withering of the outer leaves then follows, and finally the whole head dies and falls off. " The conditions resemble those which would be caused by drought or some general disturbances and not by a local disease at the crown of the palm. No trace of any parasitic fungus can be found in the earlier stages at the top of the tree. The stem is generally healthy. Below ground, however, matters are different. Here there is invariably a rot, either of the roots or of the below-ground part of the stem even in very early cases." Reasoning from analogy with other root fungi, Butler recommends the surrounding of affected portions by trenches. But to be effective, trenching must be undertaken as soon as the first disease appears in the garden. The trench should be two feet deep, about a foot broad, and drained so as to prevent water accumulating in it. It should entirely surround and cut off the first affected palm or palms. [*Cf. Pests and Blights of the Tea Plant*, 1903, 413.]

Bombay.

White-ants.

A Borer.

Of Godavari, it has been said that white-ants often injure the palm materially by eating the rootlets. Of Bombay, Mollison (*l.c.* 262) observes, " Betel-palms are not much affected with disease. A borer does considerable damage. It cuts a tunnel from the root upwards and in time reaches to the growing top. The damage there done is so considerable that the top withers and when wind blows breaks off and falls to the ground."

Bengal.

Plague.

Indolence.

Loss of Revenue.

The investigations conducted by me in the great betel-nut area of Bengal left the impression on my mind that there was less to be surprised at in the severity of the plague that devastates the plantations than in the infrequency of its occurrence. It is next to impossible to imagine any industry existing at all under the conditions of abject neglect that prevail in the Bengal betel-nut districts. All that the owner of a plantation does is to lay the estate out on the principle of the greatest number of trees on the least space, and at the lowest labour and expense possible. He then builds his house, and he and his sons and grandsons settle down to a life of family disputes that not infrequently lead to lawlessness. He hires out his plantation to contractors who collect the fruits in any way they think fit, the owner all the while sitting by in a state of complete indifference and indolence. He neither drains, manures, nor cultivates his plantation in any form worthy of the name but lives in opulence until plague appears, when, if his property chances to be devastated, he gathers together his movable goods and leaves the district inorder to escape payment of the revenue or rent during the twenty years of renovation that may have to be faced.

Dead stumps.

Destruction of Tissue.

Causes of Plague.

Remedy.

After the most careful examination of numerous plantations (or rather jungles) of betel-nut palms in Eastern Bengal I failed to find any serious insect or fungal blight on the trees that were nevertheless seen to be dead and dying in every direction. The crown of leaves withered and was blown off, leaving a dead stump behind, until what was once a plantation looked like a harbour with thousands of masts. The destruction was not confined to particular plantations but had spread over the country like a great wave of infection in such a manner as to justify the name of " Plague " that had been given to it. On microscopic examination, the tissue of the dead and dying palms was found to be permeated with an organic agent of destruction in which it might be said that the fundamental tissue had invaded and devoured the fibrovascular. The condition, in other words, was very similar to that described under the name " *Tyloses*." As seen in Europe on the vine, the cucumber and other plants, *that* constitutional disease is believed to be induced when an undue amount of moisture is given to the roots, while the leaves are at the same time exposed to an abnormally dry, hot atmosphere or the reverse conditions. The cultivators in Bengal admit that plague follows when the soil becomes abnormally dried up, through failure of the customary showers in January, more especially if the hot months are ushered in by a cyclone. The remedy lies in more generous spacing, when laying out the plantation ; more careful cultivation, in which drainage, irrigation and

Combination with other Fruit Trees.

manure are provided; and lastly an extension of the system of combination of betel-nut cultivation with that of other fruit trees. The cultivation of surface crops such as vegetables, ginger, tobacco, pepper-betel, etc., would also no doubt prove not only profitable but beneficial to the palms. They would retain moisture in the soil and preserve a healthy balance in its food materials. But in the country where betel-nuts are grown on a large scale and with the class of people who engage in that remarkable branch of agriculture, such preventive measures would perhaps be next to impossible, unless they could be made compulsory.

Nut.

Boiled.

Dried.

Trade Qualities.

MANUFACTURE.—Preparation of the Nut.—It would take many pages to detail the various methods of preparation pursued in Bengal, Assam, Manipur, Burma, Madras, Mysore and Bombay. In some cases the shelled nuts are boiled, in others not; occasionally the nuts either before or after boiling are sliced or cut up into variously shaped pieces; lastly certain qualities of the nut are recognised according to region of production and variety of plant or degree of maturity at which collected. On this subject the authors of the *Pharmacographia Indica* (*l.c.* 532) say: "The varieties of the nut met with in trade are numerous; they may be classed as natural and artificial: the first class includes different varieties of ripe betel-nut produced by cultivation which have not undergone any preparation; the second class, all nuts, ripe or unripe, which have been treated by boiling or other process before being offered for sale." Mollison observes that in Kanara the nuts after being boiled are dried in the sun and sorted into three kinds, viz. *chikni*, *betta*, and *gotu*. The first and the best quality sells at Rs. 6 to 7, the second at Rs. 3 to 4, and the third at Rs. 2 to 2½. Taylor describes the Bengal method of shelling and cleaning the nuts before being sent to market. Briefly it may be said the fruits are cut off the branches, collected in baskets and spread out to dry, most frequently on the roofs of the houses. They are never boiled, but are simply cut open and assorted according to size.

Extract.

Repeated Boiling.

Kossa.

The Extract.—Mollison says—"The scraped nuts are boiled for about two hours in fairly large copper pots. A handful of lime or of the ash of the bark of *matti* (***Terminalia tomentosa***) is added to the water. The presence of lime causes the water to become red or red-brown in colour as the boiling proceeds. The water also becomes thick with a resinous extract from the nuts. The boiling is continued until the eye-bud or germ of growth from each nut comes out or becomes absorbed in the extract. The nuts are removed by a long-handled ladle (*zára*). The ladle has perforations in its bowl which allow the extract to drain from the nuts back into the pot. The extract is again and again used for boiling fresh supplies of nuts, pure water as required being added from time to time to prevent the decoction becoming too thick and concentrated. The extract after being used for boiling repeatedly becomes deep red-brown and thick. It is then emptied into another broad-mouthed vessel which is placed under full exposure to the sun. The mass by evaporation thickens and ***Areca Catechu*** or *kossa* is the product." Several other writers allude to this extract. In the *Dictionary* passages from *The Thana Gazetteer*, and from Baden Powell's *Panjáb Products* will be found. Very little of a definite nature is known regarding it, however, further than that it is always prepared when the nuts are boiled and is used to flavour and colour inferior nuts. But no particulars are available as to the existence of a separate trade in the extract *kossa* itself.

Properties and Chemical Composition.—The reader is referred to the *Pharmacographia Indica* for full particulars under these headings.

Uses.
Masticatory.
Medicine.
Intoxication.

Briefly it may be said that the chief use of the betel-nut is as an astringent and stimulating masticatory. To some extent it is employed in MEDICINE, the unripe fruitsare in India viewed as laxative and carminative, and a paste of the powder of the dry or burnt nut is used as a dentifrice. In Europe the ripe fruits have been employed as an anthelmintic and astringent. Most writers affirm that occasionally the nuts (especially when eaten fresh) are found to possess intoxicating and poisonous properties. This is believed to be an accidental peculiarity of certain trees which thus show a reversion to what may be the wild condition. This poisonous property has been ascertained to be destroyed by boiling, and hence no doubt has come into existence the system mentioned above of preparing the nuts for market by various methods of cooking. It has been ascertained that the active and poisonous principle present in areca-nut is an alkaloid *Arecoline.* The antidote to this, as recommended by Rumphius (in 1741 A.D.), is said to be salt, lime-juice or acid pickles.

Trade.

Foreign Imports.

TRADE.—Betel-nuts are not only very largely produced in India but are imported from Ceylon, the Straits Settlements, Sumatra and China. In 1895-6, the year before the effects of the Bengal betel-nut plague became serious, the foreign imports stood at 58¼ million lb., valued at 36½ lakhs of rupees. Steadily these imports improved until in 1899–1900 they stood approximately at 90 million lb., valued at 62¾ lakhs of rupees. These figures may be accepted as representing a loss to the Indian producer of 26 lakhs of rupees. This opinion may be confirmed in various ways. In my report on the ravages of the betel-nut plague it will be found that I have stated that in many plantations visited there was a loss of from 50 to 90 per cent. of the trees. The returns of the river traffic from the betel-nut area into Calcutta, showed for 1895–6 a decrease of 8 million lb., as compared with that of the three previous years. The trade still further declined for the two following years but revived very greatly subsequently, and has now been more thanrestored to itsformer magnitude. It will thus be seen that during the disturbed years above indicated production in Bengal decreased by the exact amount that the foreign imports increased, involving a loss during these years of some £200,000 per annum to the betel-nut growers of the province. But since 1900 the foreign imports have continued to increase, till in 1906–7 they reached 119,732,410 lb., valued at Rs. 1,15,35,030. The foreign exports were 280,782 lb. in 1896–7, and for the five years ending 1906–7 they were 375,050, 341,937, 320,176, 343,526, and 289,770 lb. To these amounts would have to be added the re-exports, which in recent years have varied from some 20 to 40 thousand lb.

Foreign Exports.

Production.
Coasting Trade.
Internal Trade.

The magnitude and importance of the Indian production of betel-nuts may, however, be judged of by the extent of the coasting trade. During the three years ending 1905–6 the inter-provincial exchanges have ranged from 57 to almost 64 million lb. of Indian-grown nuts valued at from 82 to 89 lakhs of rupees. Of that amount Bengal has exported from 32 to 37 million lb. Burma is the largest importing province, and has taken from 29 to 34 million lb. Of the internal trade mention may be made of Assam. It produces these nuts chiefly in Sylhet and Gauhati, but the large number of Indian coolies concerned in tea-planting are dependent on the supplies drawn from Bengal. Madras is supplied very largely by the Malabar Coast, and the exports of South India go mainly to the Straits while Bengal exports to Burma. Judging by the coastwise trade alone, the chief areas of production are Bengal, Bombay, Madras and Goa, mentioned in the sequence of their importance. A certain proportion of the quantities recorded as carried by rail and river appear again in the sea-borne traffic (the coastwise and foreign exports) or they have been derived from the foreign imports, but allowing for all such necessary corrections, the transactions by land routes must be accepted as greatly augmenting any estimate that might be framed as to the total quantity and value of the Indian production. But over and above all published returns there is still a source of error (and in this case an important error) in the local or village cultivation and consumption which escapes registration entirely. As a deduction from the estimate that might be arrived at from the study of foreign supply *plus* Indian production, the Foreign Exports would have to be accounted for, say 250 to 350 thousand lb. These go mainly from Bombay ports and are derived chiefly from the coastwise imports from the other parts of that Presidency with a smaller supply from Goa and Madras. Madras is the next most important exporting province. Bengal, the chief producing province, exports very little to foreign countries. The Trans-frontier (land) traffic from India to Kashmir, Nepal, Bhutan, Manipur, the Shan States, etc., has during the three years ending 1906–7 been 53, 46, and 64 thousand lb.

Village Consumption.

Foreign Exports.

Total Transactions.

Prices.

From the published returns of foreign imports and Indian production, briefly indicated, it would seem safe to affirm that the annual consumption of betel-nuts in India itself cannot be far short of a valuation of Rs. 225 lakhs, or say £1,500,000. The price adopted in making that calculation has been obtained from the mean of the declaration value in the foreign imports and internal traffic for a period of five years. But if the foreign imports alone be considered, the price would seem to be from Rs. 5·78 in 1895–6 to Rs. 7·87 in 1898–9 and Rs. 6·98 subsequently per 100 lb. of nuts. These figures correspond sufficiently nearly with those given by O'Conor, viz. Rs. 6–5–8 per maund, risen recently to Rs. 7–8–0. The retail price may therefore be expressed at 2½ to 3 annas per lb. The following quotations from the Bombay market price list of different trade qualities may be regarded as amplifying the above average calculations :— *White Betel-nuts.*—Goa, Rs. 8 to 10 per cwt. ; Mangalore, Rs. 14 to 22 per cwt. ; Rupasi, Rs. 12 to 16 per cwt. ; Calcutta, Rs. 12 to 13 per cwt. ; Asigree, Rs. 12 to 14 per cwt. ; Kanarese, Rs. 16 to 20 per cwt. ; and Severdani, Rs. 18 to 19 per cwt. *Red Betel-nuts.*—Malabari, Rs. 14 to 16 per cwt. ; Kumpta, Rs. 12 to 18 per cwt. ; Marorkhudi, Rs. 16 to 17 per cwt. ; Goa, Rs. 24 to 32 per cwt. ; Wasai, Rs. 20 per cwt. ; Malwa, Rs. 12 to 13 per cwt. ; Vingorla, Rs. 12 to 13 per cwt. ; and Calcutta, Rs. 10 to 12 per cwt. It would appear that the poorer classes use various substitutes for the betel-nut, for example the seeds of *Calamus erectus, Roxb.*

D.E.P., i., 302-4. Sago-palm.

ARENGA SACCHARIFERA, *Labill.* ; *Fl. Br. Ind.*, vi., 421 ; Roxb., *Trans. Soc. Arts,* 1804, xxii., 366–8 ; 1806, xxiv., 155 ; Gamble, *Man. Ind. Timbs.*, 728 ; Dodge, *Useful Fibre Plants of the World*, 66 ; PALMEÆ. The Sago-palm of Malacca and the Malaya, *taung-ong, eju, gumúti*, etc. ; very commonly cultivated in India and wild in the forests of Burma and Assam. It flowers about the tenth year.

Fibre.

At the base of the petiole is found a beautiful black horsehair-like FIBRE known as the *Ejú* or *Gomuta* Fibre. Within the sheaths is a layer of reticulated

Food. **Yield of Sugar.** **Yield of Sago.**

fibres said to be in great demand in China for caulking boats. It is also used for kindling fires and in Manipur to filter water. It has been recommended for ropes intended for use under water and even as covering for submarine telegraph cables. The coarsest fibre is only fit for brush-making. For this purpose the leaves are first washed and then soaked in an alkaline solution (Morris, *Cantor Lect., Journ. Soc. Arts.*, Oct. 18, 1895, 931). Sandals are made from the leaf-sheath. [*Cf.* also Roxb., *Obs. on Substitutes for Hemp and Flax,* 1809—a paper which gives some results of a comparative test with *ejú* fibre.] The sago from the interior of the stem, although inferior to that obtained from the true sago palm (**Metroxylon Sagu**, *Rottb.*), is nevertheless an article of FOOD. It is the source of the Java Sago, which is of considerable importance throughout the Malaya, although the palm is chiefly cultivated for its sap from which palm-wine (*toddy*), spirit (*arak*), sugar and vinegar are prepared (see **Malt Liquors**, p. 760). A long and interesting account of the process of extraction of the sap (Simmonds, *Trop. Agri.*, 248) will be found in the *Dictionary* (i., 303), and Tschirch (*Indische Heil und Nutz-Pflanzen,* 159–161, pl. 97) describes the uses and appearance of the palm in Java. The latter observes that it is not worth while to grow the palm for sugar because its production per acre is insufficient. He gives the yield for Java as about 8,000 lb. per hectare (say 2½ acres). The estimate quoted by Simmonds is about 6,600 lb. to the acre. Jumelle (*Les Cult. Colon. Pl.* (*Aliment.*), 27) says that about 400 trees can be planted to the acre and from each tree can be had 154 lb. of sago, giving the enormous total of 61,600 lb. to the acre. Roxburgh remarks that one palm gave about 150 lb. of good sago-meal. The palm will grow on soils where the cultivation of cereals could not succeed. "The palm dies after ripening its whole crop of fruit, and the stems, which speedily become hollow, are then useful for troughs and water-channels, lasting well underground" (Gamble, *l.c.* 728). [*Cf.* Milburn, *Or. Comm.*, 1813, ii., 310; *Der Tropenpflanzer,* iii., 498–500; v., 364–5.]

A. Wightii, *Griff.*; Talbot, *List Trees, etc.*, 1902, 340. This is the *dadsel,* a palm which according to the excise reports is often tapped for toddy.

D.E.P., i., 321-2; v., 496-7; vi., pt. i., 399.
Arsenic.

ARSENIC (Oxide), including **Orpiment** and **Realgar**; Ball, *Man. Econ. Geol. Ind.*, 1881, 162, 592, 606; Holland, *Rec. Geol. Surv. Ind.*, xxxii., 97. This metal is met with commercially in India in either of the three forms:—the *Oxide,* commonly called White Arsenic or Arsenious Acid, *safed sambul, somal,* etc.; the *Sulphides,* known as Orpiment, Yellow Arsenic, *haritala, hsae-dan,* etc.; and *Realgar,* Red Arsenic, *mansil,* etc.

White Arsenic. Orpiment. Sources. Mines. Imports. Exports.

White Arsenic is purely a manufactured article obtained by sublimation in the smelting of arsenical pyrites. The sulphides are natural minerals, though they can be artificially produced. Of orpiment there are two qualities, (1) the medicinal and criminal form, consisting of smooth shining scales, which is chiefly imported into Bombay from the Persian Gulf ports, and (2) the coarser and less poisonous form, which occurs in opaque masses. The sulphides of arsenic are regularly drawn from Munsiari in Kumaon, from Chitral and from Upper Burma and Yunnan. An interesting account of the orpiment mines of Chitral will be found in *The Pioneer* (Sept. 9, 1898). That from Munsiari is brought by the Bhutias to the Bagesar fair. Orpiment is also carried from the Swat country and Kashgar to Peshawar, and from Herat to Kandáhar. All three forms of arsenic have always been imported from Burma and China, and although white arsenic is now mainly brought by sea, the sulphides still form a valuable transit-trade from Western China through Upper Burma. There has been some trade, both export and import, in arsenic. The average export of Indian arsenic (excluding orpiment) from 1897 to 1903 was about 334 cwt., valued at £525, whilst the average import was 2,346 cwt., valued at £3,110. In 1906–7 the exports were 106 cwt., valued at Rs. 2,233, and the imports 1,925 cwt., valued at Rs. 44,196. The imports of orpiment into Burma from Western China averaged in 1897–1903, 9,551 cwt., valued at £11,470. The tendency seems to be for the trade to increase whilst prices fall.

Poisoning.

It may be mentioned of white arsenic, that of all poisons it is the most frequently resorted to, especially in the Panjáb, which has about 50 per cent. of the recorded cases of such poisoning. In the *Annual Report* for 1902 the Chemical Examiner, Panjáb, observed that 64 per cent. of the cases of human poisoning in that year were with arsenic. However, by the Poisons Act of 1904 very wide discretionary powers were granted to the local Governments, subject to the control of the Governor-General in Council. Special restrictions are placed upon the traffic in white arsenic. Orpiment, besides being a PIGMENT and a DYE, is an essential ingredient in the manufacture of shellac, lac toys, Afridi wax-cloths, etc. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 99, 156, 173; Watt, *Ind. Art at Delhi,* 1903, 211, 221-2, 231; Hooper, *Rept. Labor. Ind. Mus.*, 1903-4, 36.]

Pigment and Dye.

ARTEMISIA, *Linn.*; *Fl. Br. Ind.*, iii., 321-30; COMPOSITÆ.

D.E.P., i., 323-8.
Worm-wood.

A. absinthium, *Linn.*; Heuzé, *Les Pl. Indust.*, 1895, iv., 343-9. The Absinthe, Wormwood, *afsanthín, viláyati-afsantín.* An aromatic herb met with in Kashmir at altitudes of 5,000 to 7,000 feet; distributed to North Asia, Afghanistan, and westward to the Atlantic.

Oil.

This wormwood yields by distillation a dark green or yellow OIL having a strong odour of the plant and an acrid taste. In large doses it is a violent narcotic poison. In MEDICINE the whole herb is considered an aromatic tonic and anthelmintic, but in Europe is now relegated to the position of a domestic medicine. A liqueur consisting of an alcoholic solution of oil of wormwood with flavouring ingredients forms the Absinthe so largely consumed in France. Foster (*Engl. Factories Ind.*, 1618-21, 338) alludes to "wormwood wine" among the articles provided for the Company's ships.

Medicine.

Santonin.

A. maritima, *Linn.*; *Pharmacog. Ind.*, ii., 288. Wormseed, Santonin, *shih, kirmálá, kirmári-owa* (or *kirmáni ova*), etc. A very variable plant found in the Western Himalaya from Kashmir to Kumaon, altitude 7,000 to 9,000 feet, and abundant in Western Tibet on salt-plains between 9,000 and 14,000 feet. The Levant wormseed of European commerce comes from Persia, Asia Minor, etc., whilst the Barbary wormseed comes from Palestine and Arabia.

Medicine.

The flower-heads are largely used for their anthelmintic, deobstruent, and stomachic-tonic qualities. Santonin is now well known to the Natives of India and is largely imported from Germany, but according to Dr. von Schroeder it is not poisonous to ascarides as was formerly thought, but merely drives them into the large intestine whence they can be removed. Wormseed is brought from Russia and also from Afghanistan and Persia, its value being about Rs. 2½ to 3 per Surat maund (37½ lb.), but much of the prepared santonin sold in the bazárs is adulterated to the extent of three-fourths with gum, boracic acid, etc. Details of the trade are not available. Duthie observes that in the Himalaya ponies are fed upon this plant with relish, and he adds that "other species of *Artemisia* are mentioned as affording good fodder for sheep on the Panjáb Himalaya." The *Kew Bulletin* (June 1893, 127), commenting on this, observes that in localities where hardly any other vegetation exists, the use of the wormseed as a fodder plant might prove of value. Church reported on a bundle of dry leaves received at Kew from Duthie. The following is his analysis :—

Fodder.

Percentage composition of *Artemisia maritima* :—

Water	13·6
Oil, resin, wax, etc.	4·0
Starch, sugar, gum, etc. (by difference)	34·2
Albuminoids (true)	6·0
Fibre	33·9
Ash (includes 2·7 of sand and mica)	8·3

Church remarks that the plant contains rather less albuminoids, less digestible carbohydrates, and more fibre than the average hay of mixed grasses. It is, however, thrice as rich in albuminoids as the straw of European cereals. The harsh woody texture of the plant and its sickly odour would not commend its use as the chief ingredient in horse-fodder; but to any animals not deterred by these factors it might prove of considerable value under such special circumstances as obtain in barren tracts of the Western Himalaya. *A. parviflora* is also browsed by sheep and goats. [*Cf. List of Himalayan Fodder Plants* (excluding grasses), *D.E.P.*, iii., 427.]

Worm-wood.

A. vulgaris, *Linn.*; Indian Wormwood, Flea-bane, *nágdoun, nágdoni, tataur, surband,* etc. A gregarious shrub found throughout the mountainous district of India and distributed to temperate Europe, Siam, Java, etc.

Medicine.

One or two of the forms of this species, along with *A. Absinthium,* constitute the officinal wormwood, but by itself *A. vulgaris* is not an article of commerce. In MEDICINE it is held to have stomachic and tonic properties, and the modern Hindus regard it as deobstruent and emmenagogue. It may be used as an inferior substitute for cinchona in intermittent fevers, and is probably one of the sources of the remedy known to the Muhammadans by the generic title of *afsantin.* Said to be used in China in the preparation of an external application (*moxa*) employed in relieving pain (Bretschneider, *Hist. Europ. Bot. Disc. in China*, 1898, 234). [*Cf.* Hartless, Note, April 9, 1897; see **Alkalis**, etc., p. 50.]

D.E.P., i., 329 33.
Jack-fruit.

ARTOCARPUS INTEGRIFOLIA, *Linn.*; *Fl. Br. Ind.*, v., 541; Gamble, *Man. Ind. Timbs.*, 652; URTICACEÆ. The Jack-fruit tree; *kánthál kántál, káthál, panasa, phala, kantaka,* etc. A large evergreen tree cultivated in the warmer parts of India and Burma and occurring wild on the Eastern and Western Ghats up to altitudes of 4,000 feet. The dense mass of dark foliage and the huge fruits make this tree a prominent feature of most Indian villages.

Of the 40 odd species of ***Artocarpus*** indigenous to tropical Asia and the Pacific, only five are of economic importance in India. The four besides ***A. integrifolia*** are:—(1) ***A. Chaplasha***, *Roxb.*; *chaplash, sam, cham, pani,* etc., met with in Eastern Bengal, Assam, Burma and the Andamans; (2) ***A. hirsuta***, *Lamk.*; the *pat-phanas, anjalli, ayni, hebalsu,* etc., which occurs in the Western Ghats up to 4,000 feet; (3) ***A. incisa***, *Linn.*; the Bread-fruit, *divy-halasa* (*divy-jack*), *rata-del,* etc., an introduced South Sea species cultivated in S. and W. India, Ceylon and Burma, but unable to hold out against the Bengal winter; (4) ***A. Lakoocha***, *Roxb*; the *lakucha, dhea-phal, lovi, kamma-regu, myouk-lok,* etc., found in Kumaon, Eastern Bengal, South India and Burma.

Gum. Cement. Dye. Lac. Fibre. Medicine. Beverage. Timber.

The bark yields a true GUM and the juice forms a useful CEMENT. CAOUTCHOUC is obtained from all the above-named species, but the amount is very small (Hooper, *Rept. Labor. Ind. Mus.*, 1905–6, 26); that of ***A. incisa*** is employed as a glue in caulking canoes. A yellow DYE or PIGMENT is obtained by boiling the wood and sawdust (especially from the root of ***A. Lakoocha***), and this is employed in Burma, Madras, and elsewhere in dyeing the garments of priests (*Agri. Ledg.*, 1896, No. 4), but it is said not to dye with mordants (*Text. Mercury*, Jan. 25, 1896). The LAC insect is in Assam often obtained from ***A. Chaplasha***. The bark yields a FIBRE, that of ***A. incisa***, being used apparently for clothing in Otaheite and other islands (Royle, *Fibrous Plants*, 341). The juice, leaves and root are employed in MEDICINE. The FRUITS of all the above species are eaten occasionally, but that of ***A. integrifolia*** is of course most sought after. It is mentioned by almost all the early European writers, and in the *Ain-i-Akbari*, 1590 (Blochmann, transl., 66, 70). The name Jack-fruit was given by the Portuguese from the Malayalam *tsjaka.* Kircher gives it the Chinese name of *po-lo-mi.* Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 159) calls it *ciccara.* The fruit is seldom eaten by Europeans owing to the smell of the ripe pulp, but the Natives regard it as one of the best fruits of the country. It is, as a rule, from 12 to 18 inches long, by 6 to 8 inches in diameter, and should be called a frutescence. If the component flakes be fermented and distilled they yield an alcoholic beverage, and the roasted seeds taste not unlike chestnuts. The TIMBER of all the species seasons well, and is considered valuable, being used for canoes, doors, frames, etc. That of ***A. hirsuta*** is the *anjeli*-wood of commerce, and that of ***A. integrifolia*** is exported to Europe for cabinet-work, turnery and brush-backs. [*Cf.* Vertomannus, *Travels*, in *Hakl. Voy.*, 1811, iv., 585; Barber, *Memoirs*, 1519 (Leyden and Erskine, transl., 325); Garcia de Orta, 1563, *Coll.*, xxviii.; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), ii., 20; Pyrard, *Voy. E. Ind.*, 1619 (ed. Hakl. Soc.), ii., 366; Clusius, *Hist. Exot. Pl.*, 1605, 281; Boym, *Fl. Sin.*, 1656, L; Kircher, *China Illust.*, 1667, 186 and pl.; John Ellis, *The Mangostan and Bread-fruit*, 1770; *Taleef Shereef* (Playfair, transl.), 1833, 116; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 296; etc., etc.]

D.E.P., i., 338.

ASBESTOS; Ball, *Man. Econ. Geol. Ind.*, 518–9, 631; Holland, *Rec. Geol. Surv. Ind.*, xxxii., 99. A fibrous variety of amphibole which in Bombay has been called *shank-ha-palita* (wick made of shells). It is reported to occur in Afghanistan, the Panjáb, Garhwal, Bhopawar (in Central India), Chota Nagpur, and Mysore.

The average recorded yearly production in India would seem to be insignificant, namely about 5 to 6 cwt., valued at Rs. 40 to 48, but the great increase in the demand for fireproof materials has resulted in efforts being made to discover new and more profitable sources of supply (*Min. Rev.*, 1896–7). Recent discoveries in Central India and Rajputana seem likely to prove of value. In November 1899 two samples of asbestos found in the Jobat State, Central India Agency, were sent to the Imperial Institute, London, for analysis and report. The Director replied that both samples consisted of soft friable asbestos chiefly of very short staple. They were of inferior colour, even the so-called white variety being grey and impure. A commercial expert was of opinion that it would not pay to bring it to Europe, but that it might be found useful locally for fireproof packing, decorative work, etc. [*Cf.* Yates, *Tex. Antiq.*, 1843, 356–65; *Textile Mercury*, April 11, 1896; Hanausek, *Micro. Tech. Prod.* (Winton & Barber, transl.), 1907, 156-7.]

ASTRAGALUS HERATENSIS, *Bunge; Pharmacog. Ind.*, i., 479; Aitchison, *Trans. Linn. Soc.* (*Bot. ser.* 2), 1888, iii., 49, pl. vi.; *Edinb. Trans. Bot. Soc.*, 1891, xviii., 17; Heuzé, *Les. Pl. Indust.*, 1895, iv., 267-8; LEGUMINOSÆ. Indian Tragacanth, *katira*, *gabína*, *kom*, *kón*, *kum*, etc. A Persian shrub, very common in the stony soil of the Harirud valley and Khorasan, at an altitude of 3,000 feet.

D.E.P.,
i., 347-9;
vi., pt. iv.,
71.
Tragacanth.

From this and perhaps several other species is obtained a GUM called *katíra* or *gabína* which exudes from fissures in the bark. This is known in Indian commerce as Tragacanth. It is further said that on the stem being cut across, the gummy substance shoots out of the medullary cavity in the form of pipe-Tragacanth. Aitchison observes: "This is collected in large quantities near Bezd in Khorasan for exportation in all directions to India, Persia and Turkestan to be chiefly employed in the stiffening, glazing, and facing of local fabrics. Most of the gum sold in India as *katíra* is this and not the product of any Indian plant." Possibly another species (**A. Sarcocolla**, *Dymock*; *anzerut*, *anzrud*, *gújar*, *gúzhad*, etc.) is the drug which was known as *sarcocolla* to Pliny, Dioscorides, Avicenna, etc. It is hardly, if ever, met with in Europe at the present day, although still used in the East. The gum is imported into India, and is one of the principal ingredients in the *lép* (plaster) employed by Parsis to set fractured bones, etc. The average value is said to be about Rs. 3 per maund of 37½ lb. Aitchison is of opinion that without further knowledge of the plant than was derived from finding the fruit of an **Astragalus** amongst the gum and from an experiment with the seed, it would have been better not to identity this as a new species, since in all probability it will be found to be a form already described by Bunge. The drug consists of pale-yellow irregular grains not unlike crushed resin, and is said to be collected by being shaken off the tree on to a cloth. Eaten by ladies to improve their appearance and to give the skin a gloss.

Lép.

Astragalus (Tragacanth) Substitutes: the Bassora or Hog-gums of India.— This is a group of gums resembling Tragacanth, but much inferior, the colour being most objectionable. The collective name in commerce is BASSORA GUM, given because the gum of this class which first attracted attention is supposed to have been exported from Bassora. In India these gums are collectively known as *katíra*, though Aitchison observes that most of the *katíra* gums are non-Indian in origin. Chemically *Tragacanthin* and *Bassorin* are probably identical. The Indian Bassoras or Hog-gums are as follows:—

D.E.P.,
i., 416.
Bassora or Hog-gums.

Ailanthus excelsa.
Bombax malabaricum.
Cochlospermum Gossypium.
Moringa pterygosperma.
Prunus Amygdalus.
Saccopetalum tomentosum.
Sterculia urens.
Stereospermum suaveolens.

ATROPA BELLADONNA, *Linn.*; *Fl. Br. Ind.*, iv., 241; SOLANACEÆ. Deadly Nightshade, *sangangúr*, *angúr-shéfa*, *súchí*, *girbútí*, *astrung*, *yebraj*, *luckmuna*. A coarse glabrous herb native of the Western Himalaya from Simla to Kashmir at altitudes of 6,000 to 12,000 feet; distributed to Europe and North Persia.

D.E.P.,
i., 351-3.
Belladonna.

Medicine. The officinal parts of the plant are its leaves and the dried roots, which are powerfully sedative, anodyne and antispasmodic. The properties of the drug are so well known that it is unnecessary to detail them here. It appears that although the Himalaya might supply the world with belladonna, its cultivation has been but indifferently investigated. [*Cf.* Leake, *Agri. Journ. Ind.*, 1907, ii., pt. ii., 210–11; *Paulus Ægineta* (Adams, Comment., iii., 240), etc., etc.; *Pharmacog. Ind.*, ii., 572; Fluckiger and Hanbury, *Pharmacog.*, 455–9; *Rept. Ind. Hemp. Drugs Comm.*, 1894, i., 172; etc., etc.]

D.E.P., i., 354–9. Oats.

AVENA SATIVA, *Linn.*; *Fl. Br. Ind.*, vii., 275; Duthie, *Field and Garden Crops*, pt. i., 13, pl. iii.; also *Grasses N.W. Ind.*, 1883, 31; and *Fodd. Grass.*, 1888, 51; Mukerji, *Handbook Ind. Agri.*, 247–8; Mollison, *Textbook Ind. Agri.*, iii., 49–51; GRAMINÆ. The Oats and Oat Grass.

Habitat.—There are some 13 species, in addition to the cultivated one met with in India. Of the wild forms all occur on the Himalaya, their area extending from Baluchistan and Afghanistan in the west, through Kashmir, Kumaon and Nepal to the extreme east in Sikkim. The species ***A. aspera***, *Munro*, in addition to its Himalayan habitat, occurs on the Khasia hills, the Nilgiri hills and the mountains of Ceylon. Nowhere are the wild Avenas found abundantly; a few plants here and there is their usual condition, though several (such as ***A. fatua***, *Linn.*, ***A. pratensis***, *Linn*, and ***A. subspicata***, *Clairv.*) are widely dispersed, being met with very nearly throughout the temperate Himalaya.

History.—None of the truly indigenous species are ever cultivated in India. And in fact it would seem that the Natives do not recognise them as worthy of distinctive names, hence they do not separately distinguish the species, and the following names may very possibly denote any ***Avena*** including the cultivated ***A. sativa***:—*jai, jawi, jei, javi, gandal, ganer, ganhel, gozang, jandel,* etc. There would appear to be no well-authenticated classic names for either the plants or the grains in India, Africa, Arabia, Egypt, Persia, China or Japan. The *bromos* of the Greeks and the *avena* of the Latins were names given to wild species, but there is no satisfactory evidence that either the Greeks or the Romans cultivated the Oats. *Paulus Ægineta* (Adams, Comment., iii., 78) says that the chapter in Dioscorides on this subject is spurious, and that Ægineta simply translated Galen. The plant seems, however, to have been known in Asia Minor during fairly ancient times. Porridge. Caspar Bauhin (*Theat. Bot.*, 1658, 470–1) describes and figures two forms, viz. *alba* and *nuda*; and of the former he says that according to Serapion it is called *churtal* by the Arabs. A similar reference is made by the *Hortus Sanitatis* (1491) to Serapion, but I have not been able to verify the passage in question. The reference in Pliny to the Germans who lived on oatmeal porridge, would seem to imply that that was curious and interesting news to the Romans. The ancient Slav *ovisŭ* is connected with the Latin *ovis*, so that the word *avena* would therefore mean "sheep-weed." [*Cf.* Hehn, *Kulturpfl. und Haust.*, 1894, 539.] De Candolle (*Orig. Cult. Plants* (Engl. ed.), 373–6) gives the derivation of oats as from the Anglo-Saxon *ata* or *ate*. He then concludes his very interesting and instructive account of this plant as follows:—"As all the varieties of oats are cultivated, and none have been discovered in a truly wild state, it is very probable that they are all derived from a single prehistoric form, a native of eastern temperate Europe and of Tartary."

Fodder. One or two popular writers in India affirm that oats were carried there in the wake of Chungiz Khan, and that they were well known to the Mughal Emperors. In the *Ain-i-Akbari*, 1590 (Blochmann, transl., 135), mention is made of oats in the chapter on Fodder. It has also been said that Warren Hastings, when Resident at the Court of Moorshedabad, experimented with oats on the grounds of the Mothu Jheel. Be that Early Indian Records. statement as it may, the cultivation of oats in India certainly dates from at least the beginning of the 19th century, and though still unimportant has been extended all over the country, especially in the vicinity of large towns and stud farms. The grain does not appear to fill sufficiently to justify the attempt being made to introduce it as an article of human food, and moreover its liability to fall from the ears on its ripening, induces its being harvested when still green. In India, accordingly, it is used exclusively for feeding horses. If harvested late, the grains are shed and the straw loses much in feeding value. The crop is, however, of considerable value since the straw is recognised as being very much more nutritious than that of either rice or wheat.

Cultivation.

Yield.

Cultivation.—This is similar to that of barley. Duthie and Fuller say that with a copious supply of water, oats will give as many as three cuttings of green fodder, and thereafter make sufficient growth to bear a thin crop of grain. A large proportion of the Hissar oats area is treated in that fashion as a green fodder crop. An acre, Mr. Mukerji says, should yield 20 maunds of grain and 30 of straw. Mr. Mollison observes that the finest quality of grain is produced on the lower slopes of the Himalaya. The crop is grown to a considerable extent in Delhi, Hissar and Meerut districts and to a less extent in Poona, Ahmednagar, Satara and Ahmedabad. All the acclimatised forms grown on the plains of India produce long thin grain with much husk, and the weight per bushel does not usually exceed 35 to 37 lb.

Seasons.

Crushed.

In the plains oats are sown in September to October, or as soon as the rains have subsided. Mollison, for example, says of Bombay that oats are only grown as a *rabi* season crop, and always under irrigation. They grow best on well-drained friable soils of a fair depth. Very light sand and dense clay are not suitable. In fact, adds Mollison, "oats are grown on the same kinds of soil and under the same conditions as irrigated wheat and barley." The seed should be broadcasted, and about 100 lb. to the acre will be required. The crop comes to maturity in 3½ to 4 months. The grain can be threshed out on a board or trampled underfoot by bullocks. Mr. Mollison says that a fair outturn on good soil would be 1,800 to 2,200 lb. grain and 25 cwt. straw per acre. Oats as given to horses in India are invariably crushed and mixed with other food substances. [*Cf.* Butler, *Formaline Treat. of Oat Smut*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 257–9.]

Trade.

Trade.—The imports are small and come for the most part in ships that bring horses. Oatmeal is also to a certain extent imported under the heading of "provisions," but as it is not separately declared, no particulars can be furnished. But the exports are more considerable than would at first sight be anticipated. During the past 20 years or so they have fluctuated from 50,000 to 80,000 cwt., valued at from 1½ to 4 lakhs of rupees. In 1906–7 the actual figures were 55,518 cwt., valued at Rs. 2,26,022. The traffic is not, however, progressive. It goes very nearly entirely from Bengal and to Mauritius.

D.E.P., i., 359–60. Bilimbi and Carambola.

AVERRHOA BILIMBI, *Linn.; Fl. Br. Ind.*, i., 439; Gamble, *Man. Ind. Timbs.*, 119; *Pharmacog. Ind.*, i., 248; Cooke, *Fl. Pres. Bomb.*, i., 168; Duthie, *Fl. Upper Gang. Plain*, i., 132; GERANIACEÆ. The *bilimbi, blimbi, belambú, pulich-chakkay, pulusu-kává-lu, vilimbi, hainojom, kala-zoun-si*, etc. **A. Carambola,** *Linn.; the karmaranga, khamrak, kamarangá, kamrangá, tamarak, kamarakha, tamarta*, etc. This and the preceding are commonly cultivated in gardens.

These small trees, called, according to Garcia de Orta, 1563 (*Coll.*, xii.), *balimba* in Malaya and *carambolas* in Malabar, are fairly extensively grown for the sake of their fruits. It is customary to read of their having been introduced by the

Portuguese from America. The *kermerick* is not only mentioned in the *Memoirs of Baber* (Leyden and Erskine, transl., 325), of a date approximately 1519 A.D., or about 27 years after the discovery of America, but it is described in such terms as to leave no doubt whatever as to its identity. Baber gives his account of this fruit in a list of " Vegetable Products Peculiar to Hindustan," and makes no sort of suggestion of its having been only recently introduced. These facts, when taken in conjunction with the existence of a Sanskrit name, may be regarded as throwing grave doubts on the supposed American origin of the *karmaranga*. The fruits of the ***Bilimbi*** ripen about the middle of summer and are used in pickles and curries. The flowers also are sometimes preserved. Of the ***Carambola***, the leaves, roots and fruits, having antiscorbutic properties, are used as cooling MEDICINES. The fruits ripen about January, and when stewed are very palatable. The Natives sometimes eat them raw. When unripe they are astringent and are used as an acid in dyeing, or to remove iron-mould, owing to their containing much potassium-oxalate. The TIMBER is said to be employed in the Sundribans for building purposes and for furniture. [*Cf.* Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 33; Acosta in Clusius, *Hist. Exot. Pl.*, 1605, 286; Jacobus Bontius in Piso, *Ind. Utri re Nat. et Med.*, vi., 102; Rheede, *Hort. Mal.*, iii., tt. 43-4; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 162; Taylor, *Topog. Stat. Dacca*, 50; Moodeen Sheriff, *Mat. Med. Mad.*, 75-6; etc., etc.]

Timber.

D.E.P., i., 360-1.
White Mangrove.

AVICENNIA OFFICINALIS, *Linn.*: *Fl. Br. Ind.*, iv., 604; Gamble, *Man. Ind. Timbs.*, 546; *Pharmacog. Ind.*, iii., 82; VERBENACEÆ. The White Mangrove, *bina* (*bani*), *mada*, *venkandan*, *karungandan*, *tivar*, *oepata*, *thame*, *lameb*, etc., etc. A small tree or shrub of the salt marshes and tidal forests of India and Burma; found also in the Andaman and Nicobar Islands and the Malaya.

Tanning.

Timber.

The BARK of this tree is astringent and used by tanners (*Agri. Ledg.*, 1902, No. 17, 48). The ashes of the wood are used to wash cloth. The green fruit mixed with butter and boiled is made into a plaster for softening and maturing humours and to heal smallpox ulceration. The TIMBER is brittle and employed only for firewood; it is reported as used in the Andamans in the construction of oil-mills, etc.

B

D.E.P. i., 335-7, 370-94, 437; ii., 252-3; iii., 71-80, 498 v., 225, 675 vi., pt. i., 351.
Bamboos.

BAMBOOS (the Bambuseæ of botanists); *Fl. Br. Ind.*, vii., 375-420; S. Kurz, *Bamboo and Its Uses, Ind. For.*, 1876, i., 219-69, 335-62; Gamble, *Bamboos of Brit. Ind.*, *Ann. Roy. Bot. Gard. Calc.*, 1896, vii.; also *Man. Ind. Timbs.*, 1902, 746-57; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 67; Brandis, *Biological Notes on Ind. Bamboos*, *Ind. For.*, 1899, xxv., 1-25; *Remarks on Structure of Bamboo Leaves*, *Trans. Linn. Soc.*, 1907, vii., 69-92; also *Ind. Trees*, 1906, 664-85; Freeman-Mitford, *Bamboo Garden*, 1896. To economise space these works will not again be cited, though freely consulted in preparing the review that follows of the various economic bamboos of India; GRAMINEÆ.

Industrial Classification.

It is proposed to treat the Bamboos from the practical rather than the scientific standpoint, and accordingly to deal with them collectively instead of under their separate genera. But many of the purposes for which bamboos are utilised are met also by the Canes (**Calamus**, p. 202), by the Reeds, and other basket and wicker-work materials (**Baskets**, p. 115). The Canes proper are climbing palms, and the Reeds are species of grasses which, from the industrial point of view, are very nearly identical with the smaller bamboos. The Reeds proper are the species of ***Phragmites***, as also certain species of ***Arundinaria***, ***Andropogon***, ***Arundo***, ***Ischæmum***, ***Saccharum*** and ***Typha***. But many basket-materials are not grasses, and the link is thus given that carries the attempt to classify these industrial substances away completely from the Bamboo and its associates into Mats, until it becomes logically impossible to separate Cotton, Silk and Wool—the chief matting materials—from the Bamboos, the Canes and the Reeds.

The following are the chief Indian genera and species of the ***Bambuseæ*** as recognised by botanists, together with the more valuable special properties of each :—

Arundinaria aristata, *Gamble ; bhébham, babain, rato nigála,* East Himalaya, alt. 9,000 to 11,000 feet. ***A. densifolia,*** *Munro ;* the smallest of Indian bamboos, met with in South India and Ceylon. ***A elegans,*** *Kurz ;* a common species in Burma, distributed to the Naga hills and Assam, alt. 5,000 to 7,500 feet. The *jilli* bamboo of Assam, where it is used in house-construction. ***A. falcata,*** *Nees ;* the Himalayan Bamboo—from the Ravi to Nepal, alt. 4,000 to 8,000 feet. Is the *ringál, nirgál, nágre, narrí, gairí, gorwa, spíkso, ningálo, kewi, tham, utham, kutino,* etc. Culms are exported to the plains where they are worked up into *hookah*-tubes (*naicha*), fishing-rods, lining for roofs of houses, arrows, basket-work, etc. The neat little baskets used by the hillmen to hold the wool and distaff with which they beguile leisure hours is made of the *ringál* bamboo. [*Cf. Ind. For.*, 1886, xii., 414 ; xiv., 309 ; Gee, *Monog. Fibrous Manuf. Pb.*, 1891, 13.]

D.E.P., i., 335-6, 371.

Reed Bamboos.

Smallest Bamboo.

Jilli Bamboo.

Himalayan Bamboo.

Uses.

A. Griffithiana, *Munro ; khnap* or *u-spar,* a thorny shrub of the Khasia and Jaintia hills, employed to tie thatch. [*Cf. Ind. For.*, 1888, xiv., 309.] ***A. Hookeriana,*** *Munro ;* a cæspitose species of the Eastern Himalaya—the *singhani, prong,* etc. ; affords an edible seed. [*Cf. Ind. For.*, 1888, xiv., 310-4 ; *For. Adm. Rept.*, 1903, 9.] ***A. intermedia,*** *Munro ;* the *nigala, titi nigala, parmiok, prong nok,* etc. An East-Himalayan species, alt. 7,000 feet. Is an excellent hedge plant, the culms of which are strong and used for fishing-rods, baskets, mats, etc. Is largely exported from Darjeeling to the plains. ***A. khasiana,*** *Munro ;* the *namlang* (or *u-kadac namlang*), a species of the Khasia hills, alt. 5,000 to 6,000 feet. Is often specially cultivated and used for wattle-and-dab walls. ***A. Prainii,*** *Gamble ;* Naga and Jaintia hills. A graceful climbing plant which has six stamens and is known as *sampit, keva,* etc. It is used in basket-work and in hut-building, etc. ***A. Mannii,*** *Gamble,* another climbing species, may also be mentioned. It occurs in the Jaintia hills and is known as *beneng.* Is used split as a binding material in hut-building.

Edible Seed.

Fishing-rods, Baskets, etc.

Hut-building.

A. racemosa, *Munro ;* the *maling, phyeum, miknu, mheem, pheong, pathiu,* etc. A Darjeeling gregarious species extensively employed in mat-making and for roofs of Native houses, fences, garden supports, etc. Largely used in. Darjeeling as fodder for ponies (*Ind. For.*, 1888, xiv., 308-9). ***A. spathiflora,*** *Trin. ;* the high-level *ringal, garu, deo ningal,* etc., of the N.W. Himalaya (from the Sutlej), alt. 7,000 to 9,000 feet. Is the common undergrowth of *deodar* and pine. Often flowers gregariously. ***A. Wightiana,*** *Nees ;* the *chevari*—a shrubby species of the hills of Southern and Western India, specially abundant on the Nilgiris. Largely used for mats, baskets, walking-sticks, etc. ; exported to Bombay and all over India. The young shoots are eaten and the grain has often proved of much value.

Mats, etc.

South India.

Mats.

Walking-sticks.

Bambusa arundinacea, *Willd.* The Spiny Bamboo or *kanta bans, behor, bana, katanga, kalak, vas, ketúa, kataúsi, kotoha, goda, dongi, magar bans, nál bans, vedru, penti-vedru* (hollow bamboo), *múngil, kyakatwa,* etc. This tall, graceful bamboo is both wild and cultivated all over India and Burma, except in the Himalaya and Sub-Himalaya and the valleys of the Ganges and Indus. It is scarce in the Central Provinces but not uncommon in Gujarat. Very frequent in Orissa and the Karnátak, both as a small and as a large variety, and abundant in the Konkan and on the Western Ghat ranges. In the Deccan it occurs in the valleys (as it also does throughout South India), ascending the Nilgiris to alt. 3,000 feet. Scarce in Northern and Eastern Bengal and Assam, but becomes common in Burma from Pegu and Martaban to Tenasserim.

D.E.P., i., 390-1.

Spiny Bamboo.

Habitat.

Gamble tells us that it flowers about every thirty years and is reproduced by seed, but several writers in the Indian press say only twice in a century. A forest of surpassing splendour is transformed into one of desolation and death, soon followed by fire, until the charred stems, dust and ashes are all that remain. But seeding would appear to take place in sections. A writer in the

Seeding.

Gardeners' Chronicle describes the manifestation of 1862 as having commenced in Travancore, extended to Malabar in the following season, and in the next year to Coorg and Mysore.

Edible Seed.

The seeds, which somewhat resemble wheat, are EDIBLE, and have in certain years proved of great value in supplementing food-supplies, more especially since flowering very frequently accompanies seasons of famine or scarcity. Speaking, probably of this grain, Church (*Food-Grains of Ind.*, 102) gives the nutrient value as 87. He then remarks: "The food value of bamboo grain, after the removal of the husk, is high; its defects are due to the low proportion of oil and mineral matter." The analysis, he says, shows 73·7 per cent. of starch, 11·8 albuminoids, 11·0 water, 1·7 fibre, 1·2 ash and 0·6 oil. The young shoots (*kalla báns*) are greedily eaten and somewhat resemble asparagus; they appear above ground in August. The leaves are very largely employed as fodder, more especially for buffaloes and elephants. The leaves and tender twigs are also used MEDICINALLY, being supposed to possess emmenagogue properties. The silicious deposit within the joints, known as *Tabáshir*, though found in most, if not all bamboos, was first observed in connection with this species.

Shoots.
Fodder.
Medicine.
Tabashir.

The Culms.

The CULMS, which attain a height of 80 to 100 feet, and are 6 to 7 inches in diameter, are very largely employed (although this is by no means one of the best bamboos), but they are rather crooked and often knotty. At the same time the densely interlacing thorny branchlets make it difficult to extract the felled culms, hence it is not a species that would be cultivated in the commercial supply of bamboos. But as a hedge it has often proved of great value, and as Mr. Gamble says, except explosives nothing would have much effect against it. It is often badly attacked by a small hemipterous insect, an aphis which has been described under the name of ***Oregma bambusæ*** (Stebbing, *Injurious Insects*, 20–2). This attacks the leaves in such multitudes that it causes a sort of MANNA to form. [*Cf.* Taylor, *Topog. Stat. Dacca*, 1840, 61; *Pharmacog. Ind.*, 1893, iii., 586–92; Jasper Nicholls, *Journ. Bomb. Nat. Hist. Soc.*, 1893, viii., 298; also *Ind. For.*, 1895, xxi., 90–5.]

Impenetrable Hedge.
Manna.

D.E.P., i., 391. Plains Bamboo.
Strongest Bamboo for Building.

B. Balcooa, *Roxb.* The *balku báns*, *balkua*, *bhaluka*, *boro-báns*, *sil barúa*, *teli barúa*, *wamnah*, *beru*, *betwa*, etc. This well-marked and most useful bamboo is a native of the plains on the eastern side of India. The culms are 50 to 70 feet high and 3 to 6 inches in diameter; nodes swollen with a whitish ring above and hairy below. It is probably the best and strongest species for building purposes and is greatly esteemed in Calcutta, but it is not a handsome plant and would hardly be chosen for ornamental purposes. It is much used for scaffolding and is very durable if well seasoned by immersion in water, a process said to protect it from subsequent attack by ***Bostrichus*** beetles (*Working Plans, For. Jalpai*, 1898, 22.)

D.E.P., i., 392. Himalayan Bamboo.
Culms much Esteemed.

B. nutans, *Wall.* The *pichle*, *bidhuli*, *nal báns*, *mukial*, *makal*, *mahlu*, *mahl*, *paoshi-ding-ying*, *jotia*, *deobans*, *wa-malang*, *sering-jai*, etc. A moderate-sized graceful species, found on the lower Himalaya from the Jumna to Assam and Eastern Bengal, doubtfully wild anywhere west of Sarada but common near villages and along roads and canals in Dehra Dun. In Sikkim it is met with up to alt. 5,000 feet. Culms 20 to 40 feet high, 1½ to 3 inches in diameter, and having the internodes 15 to 18 inches long. Strong, straight, hard, good and much esteemed, and since they rise from the ground well apart, plantations of this species can be easily and profitably worked (Kanjilal, *For. Fl. School Circ. U. Prov.*, 1901, 367).

D.E.P., i., 392–3. Pegu Bamboo.
House-building.

B. polymorpha, *Munro.* A common species in the upper mixed forests of the Pegu Yomah and Martaban, often associated with teak and distributed westward to Assam and Eastern Bengal. The culms, which are found in dense clumps, are 50 to 60 feet high and 3 to 6 inches in thickness, much branched above and curving downwards. The species is known in Burma as *kyathaungwa* (*kya-thon-wa*), in Assam as *betuá*, and in Bengal as *jáma betuá*; is considered one of the best bamboos for walls, floors, roofs of houses, etc. [*Cf. Ind. For.*, 1876, i., 22; 1896, xxii., 70; 1897, xxiii., 131, 263; 1903, xxix. (*flowering of*), 244–5, 513–6; Alpin, *Rept. Exp. Shan States*, 1887–8; *Ind. and East Engineer*, 1897, 166, etc.]

D.E.P., i., 393 4. Common Bamboo of Rice Country.

B. Tulda, *Roxb.* The Common Bamboo of Bengal, *tulda*, *jowa*, *dyowa báns*, *mak*, *makor*, *kiranti*, *matela*, *peka*, *mirtenga*, *mitenga*, *wati*, *wamuna*, *wagi*, *nal-báns*, *deo-báns*, *bijuli*, *jati*, *jao*, *ghora*, *theiwa*, *thaikwa*, etc. This occurs in Central and Eastern Bengal, Assam and Burma, also on the hills of the Northern Circars and probably in Orissa. It is cultivated throughout Eastern Bengal and Burma, and is perhaps the most common bamboo in the rice country of Bengal and Assam. It is, however, somewhat difficult to distinguish from ***B. nutans***, and the two plants are consequently often much confused and the same vernacular names given to either indiscriminately. It flowers gregariously over considerable areas, but single flowering clumps are not unusual. The culms are green, streaked with yellow; they attain a height of from 20 to 70 feet and 2 to 4 inches in thickness. They are regarded as strong, but not so much so as those of ***B. Balcooa***. Roxburgh says that if seasoned in water they become fairly durable, otherwise they are soon devoured by a small ***Bostrichus*** beetle. The culms are used for building purposes, roofing, scaffolding, making mats and baskets, fans, window-blinds, etc., and when young are pickled and eaten.

Uses.

D.E.P., i., 394.
Female Bamboo.

B. vulgaris, *Schrad.* In Bengal this is the *básini* or *bánsini*, that is "Female Bamboo"—a name which in South India is also given to ***B. arundinacea***. In other parts of the country it is the Golden or Yellow Bamboo, *bariála, sundrogai, kulluk*, or *kallak*, or *vansa-kulaka, kulna, una, wanet*, etc. This cosmopolitan species is cultivated and runs wild over the warmer parts of India and Burma; its original country is uncertain, but it is found in Java, Mauritius, Madagascar, Algeria, the West Indies, Mexico and Central and South America, etc., etc. The culms are bright green or striped green and yellow, polished, shining. They attain a height of from 20 to 50 feet with a diameter of from 2 to 4 inches. The nodes are hardly raised but have a ring of brown hairs. The species is used chiefly in basket-making and to some extent in house-construction. [*Cf.* Lisboa, *Bomb. Grasses*, 1896, 140; Talbot, *List Trees, etc.*, 1902, 347; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 321.]

Habitat.
Basket-making.

D.E.P., ii., 252-3.
North-eastern Species.

Cephalostachyum capitatum, *Munro.* The *gobia, gope, payong, sillea, sullea*, etc. A shrubby semi-scandent bamboo found in the North-East Himalaya and in the Khasia, Jaintia and Naga hills. Is a graceful plant which often forms dense thickets. The wood is used by the Lepchas in preference to that of any other kind (for making bows and arrows), and is also regarded as good for baskets. The joints of the culms are often 2½ feet long. The leaves are employed as FODDER and the seeds are eaten in times of scarcity.

Bows and Arrows.
Fodder.

D.E.P., ii., 253.
Burmese Species.

C. pergracile, *Munro.* Is known as *latang, madang, tinwa, kengwa*, etc. A deciduous arborescent bamboo common in Burma, and after ***Dendrocalamus strictus*** is there, perhaps, the most abundant of all species. It occurs also in Chota Nagpur and Assam and is being cultivated experimentally in South India. The culms are largely used for building purposes, floating timber and mat-making. In Burma the joints are employed for boiling the *kauknyin* or glutinous rice, the effect being to produce a long mould of boiled rice which can be carried about and eaten on journeys. In Manipur I observed my coolies invariably cooked their food in joints of green bamboo. The fact of their being green and the presence of the fluid within, seemed to render the fire incapable of burning these wooden cooking-pots.

Cooking-pots.

D.E.P., iii., 71.
Kyello Bamboo.

Dendrocalamus Brandisii, *Kurz.* This is sometimes confused with ***D. giganteus***, and, like it, is often called *wabo*. Its proper names are *kyelowa, wapyu, wakay, waklu*, etc. Mr. Alpin (*Rept. on the Shan States*, 1887–8) calls it *kyello* bamboo. It is a lofty tufted evergreen species with ashy-grey culms from 60 to 120 feet in length and 5 to 8 inches in diameter. It is found in the tropical forests of Pegu and of Martaban up to alt. 4,000 feet, chiefly on calcareous rocks. It is said to flower sporadically and not to die off after flowering. Nisbet (*Burma under Brit. Rule and Before*, 1901, i., 381) says the culms are employed for boat masts.

Boat Masts.

D.E.P., iii., 71.
Giant Bamboo.

D. giganteus, *Munro.* This truly gigantic grass is a native of the Malay Peninsula but much cultivated in Burma, where it is known as *wabo* and in Assam as *worra*. It is used in Burma for posts and rafters in house-building, for carts, etc., and the joints for pails, boxes, flower-pots, etc. The large culms (often 120 feet long and 25 to 30 inches in circumference) are said to fetch Rs. 2–4 each, or in quantity, Rs. 150 to Rs. 180 per hundred. At the Colonial and Indian Exhibition, London, I had extra fine culms cut into short lengths and prepared as umbrella stands, when they readily fetched 5*s.* to 10*s.* each, according to size. [*Cf.* Varthéma, *Travels*, 1510 (ed. Hakl. Soc.), 218–9.]

Uses.
Prices.

D.E.P., iii., 71-2.
Hill Bamboo.

D. Hamiltonii, *Nees & Arn.* In the lower North-West hills this is called *chye*; in Darjeeling *tama, pao*, and *pa-shing*; in Assam and Burma *kokwa* or *kakua, wah, pecha, fonay, wanoke, wabo-myetsangye*, etc. It is a large bamboo that flowers sporadically and also gregariously. It occurs in the North-East Himalaya, Assam, Khasia hills, Sylhet and Upper Burma, and is distri-

Baskets of Darjeeling and Assam.

Edible Shoots.

Cigarette Wrappers.

buted westward to the Sutlej, though beyond Nepal it is doubtfully indigenous. The culms run from 40 to as much as 80 feet in height and from 4 to 6 inches in diameter; the nodes are marked with root-scars, the internodes are 12 to 20 inches in length, and the walls half an inch thick. It is the common bamboo of Darjeeling, the Duars and Assam, and is universally employed for all kinds of basket and mat work. For building purposes it is not much esteemed. The young shoots are eaten as a vegetable, and in Assam a specially prepared substance known as *gass-tenga* is eaten as a luxury (Hooper, *Rept. Labor. Ind. Mus.*, 1905–6, 37). The inner layer of the culm-sheath is utilised for covering Burmese cigarettes.

Tea-shade.

Referring to its straggling habit, Mr. Oliver says: "When they have no trees to support them, the main stems bend over, forming impenetrable thickets, and the lateral branches ascend vertically, often forming shoots nearly as long as the main stems." Mr. Manson alludes to the value of this species to the tea-planters of Darjeeling district in shading their plantations from hot and violent winds. [*Cf. Agri. Ledg.*, 1896, No. 27, 245, 260; Kanjilal, *For. School Circ. U. Prov.*, 1901, 369; *For. Admin. Rept. Assam*, 1896–7, 14.]

D.E.P., iii., 72. Water-pail Bamboo.

D. Hookeri, *Munro.* *The seiat, ussey, sejsai, sijong, denga, ukotang, patu, tili, kawa ule.* A large bamboo with long curving branches, met with in the Khasia and Jaintia hills, alt. 2,000 to 5,000 feet, in the Daphla hills, also Sikkim, and is distributed to Bhamo in Upper Burma. The culms are from 50 to 60 feet high and 4 to 6 inches in diameter, walls about 1 inch thick and internodes 18 to 20 inches long. The culms are used in making water and milk pails (*chungas*).

D.E.P., iii., 72. Stinging Bamboo.

D. longispathus, *Kurz.* A large and handsome bamboo of East Bengal and Burma, chiefly near streams. It is known as the *khang, ora, wa-ya* and *talagu*. *Wa-ya* in Burmese means "Stinging Bamboo," a name given in allusion to the irritating hairs on the sheath. The culms reach to 60 feet high; internodes 10 to 24 inches long and 3 to 4 inches in diameter, with the walls half an inch thick. It often roots at the nodes, and the culm sheaths are papery and more or less persistent. It is not much appreciated as a building material, though used when better kinds are not available. [*Cf. Madras Admin. Rept.* (numerous passages), 1888–9 to 1898.]

Sikkim Milk-pail Bamboo.

Churns.

Poison.

D. sikkimensis, *Gamble.* The *pugriany* of Darjeeling, *wadah* of the Garo hills and the *tiria, vola* in Nepal. A large bamboo, with cæspitose stems and few culms, but these 50 to 60 feet or more high and 5 to 7 inches in diameter. It occurs on the hills of the North-East Himalaya—Sikkim and Bhutan—at altitudes of 4,000 to 6,000 feet, also at Tura in the Garo hills, and is cultivated in several localities. It is the largest and perhaps the most beautiful species in Sikkim, where its thick culms are preferred for making the *chungas* (or pails) in which water and milk are carried and butter churned. But the leaves have the evil reputation of being poisonous to cattle and horses.

D.E.P., iii., 72 80. Male Bamboo.

Habitat.

D. strictus, *Nees.* This is the most common, most widespread and most universally used of all Indian bamboos. It is the "Male Bamboo," the *báns, báns kaban, báns khúrd, karail, mathan, mat, búrú mat, salia báns, halpa, radúr, bhiru, kark, kal mungil, kibi bidaru, sadhanapa-vedru, kauka, myinwa*, etc. Is deciduous, densely tufted, gregarious, has strong often solid culms, which average from 30 to 50 feet high and 1 to 3 inches in diameter. It occurs on all moderately dry hills throughout India and Burma, except in Northern and Eastern Bengal and Assam. In South India and Burma it reaches a large size and has hollow culms, while in the drier Deccan hills and the Siwaliks it is smaller but has nearly solid culms. Flowering is usually gregarious: the flowers appear in the cold season, the seed ripens in June and is shed, but the husk remains. After flowering, the plants die and are replaced by seedlings.

Many Uses.

Charcoal.

Fodder.

Food-grain.

Shoots Edible.

Col. Doveton (*Ind. For.*, ix., 529) gives an account of the Indian uses of this bamboo in connection with the Central Provinces, that might be consulted as it is characteristic of the species wherever found. Amongst other uses, he mentions rafters and battens, spear and lance-shafts, walking-sticks, whip-handles, the manufacture of mats, roofing, sieves, hand-punkahs, umbrellas, chairs, vessels for holding grease and oil, bows, arrows, and cordage, etc., etc. When converted into charcoal is in request for the finer smiths' work. The dry stems are also used for torches and the production of fire by friction. The leaves are much sought after as food for buffaloes and even for horses. The seed is used in times of famine as a food-grain, and the young and tender shoots are also largely eaten as vegetables (*Rec. Bot. Surv. Ind.*, 1903–4, ii., 29, 156, 196). In another paragraph particulars will be found of the recent and highly interesting discovery of manna (saccharon) seen on this species. [*Cf. Agri. Ledg.*, 1900, No. 17.]

One of the chief European uses for this bamboo is the manufacture of lance-shafts. For this purpose solid stems of uniform thickness are essential. But apparently they are only here and there completely solid. Thus the supply is unequal to the demand. Split up and again united they are made into fishing-rods. For bamboo furniture the hollow stems are now largely utilised. In India it fetches from 8 annas to Rs. 1-8 per hundred in the forests, but the transport charges to the coast are the chief items of expense. Gamble estimates the total annual production at possibly 100 million culms. [*Cf. For. Admin. Rept. C. Prov.*, 1892–3, 13–4; Lisboa, *Bomb. Grasses*, 1896, 141–4; Lovegrove, *Ind. For.*, 1900, xxvi., 433–42; Smythies, *Ind. For.*, 1901, xxvii., 126; Kanjilal, *For. Fl. School Circ. U. Prov.*, 1901, 369; Church, *Food-Grains of Ind.*, suppl., 1901, 7; Branthwaite, *Ind. For.*, 1902, xxviii., 233; Muriel, *Ind. For.*, xxix., 507–8.]

European Demand.
Fishing-rods.
Furniture.
Price.
Production.

Gigantochloa macrostachya, *Kurz.* The *tekserah*, *madi*, *madaywa*, *wanet*, *wabray*, etc. An evergreen bamboo with striped culms from 30 to 50 feet long and 2½ to 4 inches thick. Native of Assam, Chittagong and Burma. ***G. verticillata*** is the beautiful striped species often cultivated in India but introduced from the Malay. Gamble suspects ***G. auriculata***, *Kurz.* the *kalia* of Bengal and *talaguwa* of Burma, may have to be placed under ***Oxytenanthera***.

D.E.P., iii., 498.
Striped Bamboo.
Eastern Bengal and Burma.

Melocalamus compactiflorus, *Benth., Hook., f.* This arborescent, tufted and scandent evergreen occurs in Eastern Bengal and Burma, viz. from Sylhet and Chittagong down to Martaban, but is frequent only between alt. 4,000 and 6,000 feet. It is in Burma known as *wa-nwe*, in the Kachin country as *nachinwa*, in Chittagong as *lota*, and in Sylhet as *aral*. The culms are largely used for basket-work, and when split in the green state may be reduced to such fine and pliable strands that they may be woven. It is the material employed in the construction of the shoes worn by the Kachin, Shan and Chinese traders seen in Bhamo, and in the characteristic lacquered ware of Upper Burma. The seed is large, edible and mealy, somewhat resembling the chestnut. [*Cf. Ind. For.*, 1902, xxviii., 432; *Ind. Art at Delhi*, 1903, 223.]

D.E.P., i., 372.
Scandent Bamboo.
Eastern Bengal and Burma.
Woven.
Large Edible Seed.

Melocanna bambusoides, *Trin.* This is sometimes called the berry-bearing bamboo and is known by the following vernacular names—*múli*, *metunga*, *paia*, *taria*, *wati*, *artem*, *turiah*, *watrai*, *kuyaungwa*, *pagu-tulla*, *kayinwa*, etc. Is often called the Terai bamboo. An arborescent evergreen, with distant culms, arising from the ramifications of an underground rhizome. Met with throughout Eastern Bengal and Burma. In Chittagong it is perhaps the most prevalent species, and is universally employed for building purposes and mat-making. It is very largely exported to Lower Bengal, and according to the forest returns about 16 million culms are yearly required in the Gangetic Delta. It is, in fact, from the Indian standpoint, one of the most valuable of bamboos. Though thin-walled is strong and durable and has the great advantage of being straight and of possessing only very slight knots. It is doubtless the *paia* and *aworja* bamboo referred to by Lewin, who observes that white-ants will not attack it. Gregson says the young shoots are often killed by a beetle—***Cyrtotrachelus longipes*** (*Ind. For.*, xxv., 420). The fruit is large, edible and occasionally germinates and makes as much as 6 inches growth before it drops from the stem (Stapf, *Trans. Linn. Soc.*, 1901–5, vi., 409–23). *Tabáshír* is often very abundant in the stems (Roxb, *Fl. Ind.*, ii., 197).

D.E.P., v., 225.
Berry Bamboo.
Building Purposes.
Mat-making.
Trade.
Most Valuable Bamboo.
White-ant-proof.
Tabáshír.

Ochlandra travancorica, *Benth., ex Gamble*; *irakalli* (Brandis), *illa*, *irúl*, (Bourdillon). A shrubby gregarious reed or bamboo, met with on the mountains and plains of South India (in Tinnevelly and Travancore districts), up to alt. 3,000 to 5,000 feet. It has exceptionally large flowers and fruits and as many as 120 stamens in one spikelet, united more or less into a tube. The culms attain a height of 20 feet, and the internodes are sometimes 5 feet in length. T. F. Bourdillon, Conservator of Forests, Travancore State, has furnished much useful information regarding this species. It flowers, he says, gregariously every 30 to 40 years, then dies down. The shoots when 6 to 9 months old constitute a splendid paper material. For some five years or so a paper-mill was run in Travancore which used this material almost exclusively. The fibre has been pronounced superior to *esparto* but the expense of chemicals killed the industry, as it seems a larger quantity was required than with other paper materials. [*Cf. Ind. For.*, 1899, xxv., 152.]

D.E.P., i., 372.
South Indian Reed-Bamboo.
Paper Material.

podah (And.) *washut* (Garo), *bolangi báns* (Orissa). A tufted evergreen species found in Orissa, Chittagong, Burma, the Andaman Islands and Malay Peninsula. Used in house-building and for basket-work.

D.E.P., v., 675.
Eastern Peninsula Species.

D.E.P., v.,676.
Konkan Bamboo.
Umbrellas.

O. Stocksii, *Munro.* The *koda, ur sheme,* etc., a slender bamboo of the Konkan. Talbot (*List Trees, etc.*, 1902, 348) says it is commonly cultivated along the coast but is rare in the Ghat forests. It is a strong bamboo, used for punting-poles, Native umbrellas and baskets.

D.E.P., iv., pt. i., 351.
Creeping Bamboo.
Best Sikkim Basket Bamboo.
Mats.

Pseudostachyum polymorphum, *Munro; filing, purphiok, paphok, wachall, bajal, tolli, nál, bawa,* etc. Large shrubby or semi-arborescent bamboo, has culms arising singly from a long, creeping, jointed rhizome. Tall and branched at the top only, thus often taking support from neighbouring trees. Young shoots come away freely and are very straight. This species occurs in the Eastern Himalaya, Assam and Upper Burma and ascends the hills (to alt. 5,000 feet), but is most abundant and prolific in moist valleys or under the shade of trees. It is a very valuable bamboo, and in Sikkim is considered the best sort for the basket-work used on the tea estates, etc. The culms are easily split and the laths flexible and durable. It is also largely utilised in the manufacture of mats and for tying the rafters of huts.

D.E.P., i., 372.
Semiscandent Bamboo.
Water-pails.
Umbrellas.
Pan-boxes.
Mats.

Teinostachyum Dullooa, *Gamble.* A moderate-sized tufted bamboo, tending to become scandent. Occurs throughout Northern and Eastern Bengal and from Bhutan through Assam, Sylhet and Chittagong to Upper Burma. There are two forms (possibly two species), a large and a small. The following vernacular names have been recorded for these: the larger form—*dolu, dullooa, paksálu, pogslo, wadroo, gyawa;* and the smaller—*silloh, bajail, thaikwaba,* etc. The culms are used as water-pails and in the manufacture of umbrellas, also for basket and mat-work, and in the manufacture of the small boxes used to carry *pán.* It is also employed locally for building purposes. Lewin (*Hill Tracts of Chittagong,* 1869, 130) speaks of the large kind as much employed for making the mats used in loading vessels with cargo.

D.E.P., i., 372.
The Umbrella-handled Bamboo

T. Wightii, *Bedd.* The *huda, wontenulgi,* etc., is a tall semi-scandent bamboo found on the slopes of the Western Ghâts from North Kanara to Cape Comorin (alt. 3,000 to 5,000 feet). In North Kanara, according to Talbot (*List Trees,* etc., 1894, 206), it is much used in the construction of temporary bridges.

Umbrellas.

Thyrsostachys siamensis, *Gamble.* This is called "The Umbrella-handle Bamboo," or the "Monastery Bamboo" (= *kyaung-wa*) because of its being commonly cultivated in the monastery gardens, especially in Kyaukse and Meiktila. One of the most elegant of bamboos because of the regularity of its nodes. It is cæspitose and deciduous; the culms become 25 to 40 feet high and 1½ to 3 inches in diameter; are straight and not branched till high up but are covered with the persistent old sheaths. It is found in Burma from Mandalay to Tenasserim; also in Siam. It is largely exported from Moulmein and used for umbrella handles, for which it is well qualified, being light, strong and straight. [*Cf.* Mason, *Burma and Its People* (ed. Theobald), ii., 99; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 321.]

GENERAL STATEMENT OF THE PROPERTIES AND USES OF BAMBOOS.

Uses.
All Bamboos of Economic Value.

Few plants are more valuable to man, especially to the inhabitants of tropical countries, than the various species of the arborescent grasses collectively denominated the Bamboos. The *Flora of British India* describes 117 species as met with in India, and refers these to 15 genera. All bamboos may be viewed as of economic and industrial value, but the majority do not differ very materially from one another. It accordingly follows that a general statement of the properties and uses of the bamboos collectively may be of value, especially when taken in conjunction with the fairly detailed enumeration of the specific peculiarities of the better-known forms already furnished.

"The Bamboo."

The Culm or Stem.—It may be said that under most of the genera indicated one or more species of gigantic or even arborescent grasses have been described by botanists, each of which might popularly be called a "Bamboo." Many authors, however, speak of ***Bambusa arundinacea*** as "the Bamboo," an expression which is quite incorrect, since the Spiny Bamboo of South and West India and Burma is by no means either the

“The Common Bamboo.”

The most Useful Species.

The Male Bamboo.

most useful or the most abundant species in India as a whole. It is quite customary also to read of *Bambusa vulgaris* rendered as “The Common Bamboo,” whereas in India, at least, that cosmopolitan cultivated species is hardly a common plant. In the rice-producing areas it might in fact be more correct to speak of *Bambusa Tulda* as “the Common Bamboo,” and as far as Bengal is concerned that certainly is the most abundant species, although *B. Balcooa* is nearly as plentiful and ever so much more useful. On these grounds the *balku báns* would be pronounced “The Bamboo” by the people of India. The term “Male Bamboo” is given to any solid (or nearly solid) bamboo used for spear or lance staves and for walking-sticks, though it is more particularly applicable to *Dendrocalamus strictus*. *Arundinaria Prainii* and *Oxytenanthera Stocksii* have also, however, more or less solid culms.

Climatic Influence.

Umbrella Bamboos.

Fishing-rods.

Water-pail Bamboos.

Matting Bamboos.

Basket-ware.

House-construction Bamboos.

Brush-making Bamboos.

The home of the giant forms of bamboo is the tropical and extra-tropical forests; in the temperate zones they dwindle down to mere under-shrubs, until they become scarcely distinguishable from other grasses. *Arundinaria densiflora* might be described as the smallest and *Dendrocalamus giganteus* (or *D. Brandisii*) the tallest of bamboos. Some species have their stems of nearly one thickness throughout, and possess at the same time very long joints; such are specially designated as umbrella bamboos because suitable for umbrella handles. Of this nature may be mentioned *Arundinaria Wightiana*, *Oxytenanthera Stocksii*, *Phyllostachys bambusoides*, and *Thyrsostachys siamensis*. In this connection it may be observed that a Calcutta firm, who manufacture umbrellas on a large scale, have to import from China the canes they use as handles because India does not appear able to compete in quality and price with the imported article. Other species form long thin tubes such as *Arundinaria falcata*, and are, in consequence, described as *huka*-tube or fishing-rod bamboos (*Ind. For.*, 1889, xv., 92, 141). While still others have very thin and uniform shells with large cavities, and are in consequence readily adaptable for water-pails, milk-churns, drinking-jugs, and the like. Of this nature may be mentioned *Bambusa pallida*, *Dendrocalamus sikkimensis* and *Teinostachyum Dullooa*. Of a very different kind are those specially valued because of the ease with which they can be worked up into mats and baskets, as, for example, the various species of *Arundinaria*, *Bambusa vulgaris*, *Cephalostachyum capitatum*, *Dendrocalamus Hamiltonii*, *Melocalamus compactiflorus* and *Pseudostachyum polymorphum*. Burmese lacquer-ware consists very largely of neatly made boxes, trays, etc., of bamboo wicker-work coated and polished with the *thitsi* varnish (*Ind. Art at Delhi*, 1903, 218–24). Lastly, certain bamboos are prized in house and boat construction or for scaffolding, because of their great strength. These are *Bambusa Balcooa*, *B. nutans*, *B. Tulda*, *Dendrocalamus giganteus*, *D. strictus* and *Melocanna bambusoides*. Mr. Hannan (*Textile Fibres of Comm.*, 145) says: “The stems of Bamboo when spliced are known in the brush trade as the Bamboo fibre. The fibres used are about an eighth of an inch in width and 6 to 7 inches in length. They have a good elastic bending property. . . . This material is also known to the trade as ‘Patent Bass.’”

Peculiarities of Habit.

The bamboo stem, as in grasses generally, consists of a more or less hollow culm, with transverse solid joints called nodes. The thickness of the woody shell and the length of the internodes varies exceedingly in

Rapid Growth.

the different species. One peculiarity is preserved by all bamboos, namely, the rapid growth of the young shoots. This is a most important provision, for a branched shoot could never penetrate through the crowded mass of mature culms. Having in about a month reached its full height and thickness, the shoot commences to produce its branches and branchlets, and thus weighted, it curves into the graceful plume which is the elegant and familiar feature of most species.

Gregarious Habit.

Monotony of Forests.

Value to the Traveller.

Characteristic the East.

As a rule the bamboo is gregarious, establishing itself so thoroughly over certain portions of wild forest tracts that it very nearly exterminates all other forms of vegetation. Seen from a height, nothing could be more lovely, but, to the traveller who for days together may have to clear a path for himself, the interminable monotony, the twilight shade and death-like stillness, broken only by the sighing of the grating culms, make the bamboo jungle dreary in the extreme. In mixed forests, an occasional clump has a most pleasing effect. It supplies the traveller, moreover, with some of his most essential materials of equipment. Indeed, where bamboos are plentiful tents may be dispensed with, for, through the expert handling of that material, the camp followers, armed with large knives, can in a remarkably short time erect a comfortable hut and furnish it with beds, tables and chairs, all constructed from the bamboo. Sir J. D. Hooker (*Him. Journ.*) observes that it took " the Leptchas about twenty minutes to construct a table and two bedsteads within our tent." Lewin (*Wild Races of South-Eastern India*, 1870, 28–30) says : " The hillman would die without the bamboo, and the thing he finds hardest of credence is that in other countries the bamboo does not grow, and that men live in ignorance of it." A writer in *The Pall Mall Gazette* published in 1893 a charmingly told story of bamboo and its uses. He said the Orient was wreathed in bamboo; it was the one characteristic common to all the East,—bamboo was in fact symbolic of the East. Mason (*Burma and Its People* (ed. Theobald), 1883, ii., 102–3) gives a brief sketch of the varied uses of the bamboo, in which the methods of procuring fire from that material may be found specially interesting.

Popular Classification of Bamboos.

Culms to Clump.

Creeping Bamboos.

Climbing Bamboos.

Popularly, bamboos may be divided into those which grow in separate clusters or clumps, and those which send up their shoots singly from an underground root-stock, and thus form continuous patches of perhaps many miles in extent. The former are characteristic of the tropical, and the latter of the extra-tropical or temperate forests. Each clump bears from 30 to 100 culms, which attain a height of from 30 to 100, or even 130 feet. The creeping bamboos are often exceedingly valuable. Of this class may be mentioned ***Pseudostachyum polymorphum***—an East Himalayan and Burmese form—and ***Melocanna bambusoides***, one of the most valuable species and one which is extensively exported from Chittagong. Of this kind may also be mentioned ***Bambusa nutans***—a Darjeeling bamboo. The distance apart of the culms is a feature of commercial value, since the difficulty of removal of ripe culms from dense clumps is a serious disadvantage in some bamboos. A few are climbers (such as ***Arundinaria Prainii***, ***Cephalostachyum capitatum*** and ***Melocalamus compactiflorus***), their festoons and pendulous boughs passing gracefully from tree to tree.

Branching of the Bamboo.

For about two-thirds of its lower portion, the culm of most bamboos is unbranched, or possesses only very short and inconspicuous branches. On escaping from the ground the shoot attains very rapidly its full diameter and appears like a great scaly cone, clad in large embracing sheaths. Solid-stemmed bamboos are, as a rule, much smaller than hollow ones, but bamboo culms may be said to range from the thickness of a goose's quill to more than a foot in diameter. Until the branches have been fully developed the culm is not mature. The branches are produced from below upwards, and with their appearance the stem gradually matures. A good deal has been written as to the rate of growth of the shoot, but up to the present exact and definite figures, even for the important species, cannot be obtained. It is probable that an average of three inches per day would not overstate the growth of the young shoots of the more important bamboos. This seems also, in the majority of species, to take place chiefly at night and to continue for a month pretty uniformly, being increased if anything by fine clear days, and retarded apparently by damp and cloudy weather. The period of sprouting is generally about the beginning of the rains. Repeated cutting of bamboo-shoots considerably weakens the stock, while the cutting of full-grown haulms does no more injury than mowing does to grass. Indeed it is believed that too much cutting of shoots results in early flowering of the stock, and in most cases death to the plant. This fact has an important bearing upon the question of the application of the bamboo for the manufacture of paper, since young and not mature culms are necessary for that purpose. The number of shoots produced yearly from each clump varies according to the vigour of the individual and the peculiarities of the species. It is believed that the larger species produce 12 to 20 and the smaller 30 to 50. If we assume 10 a year, that would mean 300 culms in 30 years, which is the mean age of most species. The greatest possible variability exists in the colour and markings of bamboo culms. Some are pale-coloured, others dark-green, some bluish, others yellow, or again others are variegated. Solidified buds are sometimes developed into formidable recurved spines, or below the sheath a whorl of rootlets are produced which harden into spinescent bodies. These are popularly called the spiny bamboos. For the purpose of live fences the spiny bamboos are specially valuable, such as ***B. arundinacea*** and ***B. Blumeana***. The last mentioned is split and made into mats and sugar sacks in Java. Most bamboos show a tendency to flatten above the nodes; especially is this the case with ***Phyllostachys***, the genus that affords the "square" bamboo of China. The *Whangee* canes are obtained from ***P. nigra***. [*Cf. Or. Comm.*, 1813, ii., 545; *Hobson-Jobson* (ed. Crooke), 1903, 969; *Kew Mus. Guide*, No. 2, 78.]

Produced from below upwards.

Rate of Growth.

Period of Sprouting.

Bamboo as a Paper Material.

Yield.

Colour and Markings.

Spiny Bamboos.

Whangee canes.

Square Bamboos.

Durability of the bamboo depends, in the first instance, upon the culms being cut when mature. Specific peculiarities render some culms more durable than others, as, for example, the thickness of the woody shell, and the amount of silicious matter deposited within the tissue. In this latter respect bamboos vary exceedingly. Long immersion in water greatly enhances the durability, rendering the stem less liable to the attacks of insects, owing to the sap, which they are fond of, being quickly extracted.

Specific Peculiarities.

Seasoning.

Flowering.

Flowering of the Bamboo.—A great deal has been written regarding this exceedingly curious and interesting subject. All the species commence to flower when in full leaf, but as the inflorescence expands the leaves as a rule fall off, until when in complete flower the clump or certain portions of it are leafless. In some cases special flowering culms are produced, at other times every culm flowers, the flowering portion of the entire clump dying off after the seed has been matured. In a few instances the plant continues to flower as a perennial, while some bamboos are entirely annual, flowering and dying down to the ground every year. With all the larger species the flowering stage is reached after a prolonged period of vegetation, variously stated at from 25 to 50 years, and is almost regularly followed by the death of the whole stock. But the most curious circumstance in the flowering of bamboos may be said to be that while certain species are sporadic, others are gregarious. That is to say, a few plants here and there flower in the one instance, and all the plants of the same species flower simultaneously in the other. In the alphabetical enumeration above the reader will find occasional mention of this feature. According to some writers the gregarious flowering is due to specific maturity being attained at a certain age, when flowering ensues on all the plants derived from the same stock. According to others, flowering is directly a result of climatic conditions. Both opinions may be true, and this is probably the wiser solution of the phenomenon—in other words, a bamboo may not flower before it has attained a certain age, but its flowering may be retarded or accelerated by climatic influences. It is an undoubted fact that the flowering of the bamboo is decidedly influenced by the causes which bring about famine, for the providential supply of food from this source has saved the lives of thousands of persons during several of the great famines of India. Sleeman (in 1836) suggested that it might save the complete destruction of the bamboos of a district to introduce seedlings obtained from the same species found in remote localities. Whether or not this would have the desired result cannot as yet be stated. But it appears certain that it is immaterial whether cuttings are taken a few years or many years before the flowering; the parent as well as plants raised from it by cuttings, will flower and die simultaneously. Indeed it has been shown that cuttings taken a year or so before the flowering, if unable to produce flowers, nevertheless die with the rest. [*Cf.* Brandis, *Ind. For.*, 1900, xxv., 10–25; Bean, *Kew Bulb.*, 1907, 228–33.]

Sporadic or Gregarious.

Association with Famine.

Propagation.

By Seed.

Propagation of the Bamboo.—This may be effected:—*1. By Seed.*—The slowest but most satisfactory process. Some species germinate while the seed is still attached to the plant, the young seedlings dropping from the parent when about 6 inches in size. Nothing is known as to the period of vitality of the bamboo seeds, but if carefully collected and matured in the usual way, they may be sent from one part of India to the other in good condition. But this, of course, applies only to those which fall from the plant before germinating. Seedlings, however, require 10 to 20 years to attain a growth sufficient to admit of full cropping, the period varying slightly according to the species grown and the locality of production.

By Cuttings.

2. By Cuttings.—This is the process most frequently adopted in artificial production. The lower part, say 3 feet in length, of a growing half mature stem is placed in the ground shortly after the commencement of the rains. This is most frequently cut off so as to leave, if possible, a portion of the rhizome attached. The cutting should be made a little below one of the nodes and buried so as to include two nodes. Sometimes the cuttings are laid lengthwise along the ground on a specially prepared soil, and the sproutings at each node with their rootlets are afterwards severed and transplanted to their final positions.

Paper Material.

Fibre as a Paper Material.—“ Of all the fibre-yielding plants known to botanical science, there is not one so well calculated to meet the pressing requirements of the paper trade as 'Bamboo,' both as regards facility and economy of production, as well as the quality of the 'paper-stock' which can be manufactured therefrom; grown under favourable conditions of climate and soil, there is no plant which will give so heavy a crop of available fibre to the acre, no plant which requires so little care for its cultivation and continuous production." These are the opening sentences of Mr. Routledge's most useful and interesting pamphlet on *Bamboo as a Paper-Making Material,* published in 1875 (also *Bamboo and Its Treatment,* 1879). I had the pleasure of meeting Mr. Routledge during his visit to India. There seemed then a possibility of doing something with bamboo. He spared no pains to test his theories and expectations. Unfortunately he died shortly after having learned that there were practical as well as physical and chemical difficulties that seriously opposed the growth of a trade in this new paper material. These may be briefly summarised as follows :—

Objections and Difficulties.

1.—The young shoots only being serviceable for paper-making, three serious difficulties arise :—(*a*) the bamboo shoots appear from June to July and are in condition during August and September, but by the end of October are too old ; (*b*) the stock suffers severely from the removal of the shoots ; (*c*) each clump can yield only about three or four shoots a year.

Continuous Supply.

2.—Experiment seems to have failed to induce the bamboo to produce a continuous supply of shoots throughout the year.

Death of the Clumps.

3.—A large percentage of the old stems requires to be left on the stools, otherwise the plants are killed, and this same danger exists in complete removal of the young shoots. Hence methodical working of the jungles becomes essential, thus considerably increasing the charges of collection and transport. Sir George King demonstrated that if all the shoots be removed for three successive years the plant is killed. This danger may however, be averted for a time by systematic working of the clumps, but it appears to be ultimately certain to ensue.

Unfavourable Season.

4.—During the months in which the bamboo shoots appear, the climate of the most important bamboo tracts is such that labour could not be obtained. In fact, bamboo forests occupy, as a rule, uninhabited districts rendering the labour question, apart from the dangers to human life, one of the most serious difficulties.

Freight Charges.

5.—The freight and transport charges incidental to all raw products which have to be conveyed for long distances are very considerable. In fact, owing to the scattered nature of the clumps which form bamboo jungles, human labour would be the only means of collecting the material to centres from which it could be conveyed to the factory.

Poisonous Hairs.

6.—A most unexpected difficulty, which in itself almost renders the bamboo unsuitable for paper-making, exists also in the hard adpressed hairs which cover the scales and young stems. It has been found impossible to remove these, and they are not only dangerous to the men employed, but injure the paper seriously. [In passing it may be added that in Java these hairs are reputed to be used as a criminal poison. Gamble points out, however, that the difficulty in the hairs does not exist in ***Melocanna.***]

High Percentage of Chemicals.

7.—As demonstrated in Travancore with perhaps the most likely bamboo (***Ochlandra travancorica***), the amount of chemicals required is prohibitive.

Mr. M. Hill (*Ann. Rept. Board Scien. Adv. Ind.,* 1905–6, 92–3) gives a more hopeful view of the prospects of bamboo as a paper material. He there observes, "It is considered that the manufacture of paper pulp would be practicable from a commercial point of view; the prospects of an export trade for unbleached bamboo pulp appear to be favourable, having regard to the excellent quality of the pulp prepared under favourable conditions. It is estimated that a ton of unbleached bamboo pulp could be produced for £5 10*s*. including manufacturing costs, interest and miscellaneous charges. This cost, supplemented by the freight to England and sundry dues, would be increased to £7 10*s*. as the price delivered to London or Liverpool. Considering the quality of the pulp, a profit should be realised, since wood pulp is valued at £8 to £9 a ton. The manufacture of bleached bamboo pulp for export does not, however, appear to be promising chiefly in consequence of the high cost of importing bleaching powder and the deterioration of this chemical in a warm climate. The value of the pulp for local use in a paper mill in Burma is considered undoubted, and the manufacture of paper from bamboo offers favourable possibilities as a new industry for Burma."

Wiesner (*Denkscht. Akad. Wiss. Wien. Math.-Nat.*, 1902, lxxii., 7, 8), quoting Karabacek (*Das Arabische Papier*, 29), also Giles, says that the modern Chinese paper "is made from bamboo fibre, the bark of the ***Broussonetia papyrifera*** and rice straw." The late Sir Dietrich Brandis (*l.c.* 25) seemed, moreover, to think that in spite of all the disadvantages, "Bamboo paper has a future in India." He urged the necessity for a thorough inquiry into whether or not, by special cultivation, the plant could be induced to afford shoots more freely and for a longer period, without injury to the rhizome, and whether it would not be possible for mature culms to be used in paper-making. [*Cf. Journ. Soc. Chem. Indust.*, 1904, xxiii., 265.]

Medicine.

Manna.

Tabáshír.

Medicine.*—*Tabashir.—In the interior of the hollow stems of most bamboos, chiefly ***Bambusa arundinacea***, a silicious and colloidal substance is found, known in the bázars of India as *Tabáshír*; *Bánsa rochana* or *Tavak-kshira* in Sanskrit. This has erroneously been called Bamboo Manna by some writers, thereby obscuring the circumstance recently established that certain species produce a true manna on the outer surface of their culms. The following may be given as the chief vernacular names for the substance found within the stems:—*Tabáshír, bans-lóchan, bans-kapúr, thstoriyá, banasa-mítha, vás-numítha, munga-luppu, veduruppu, moleuppa, bidaruppu, tavakshírá, váchhá, vathegá-kiyo, vathegasá, vasan*. In the *Dictionary* will be found a brief sketch of the history of *tabáshír*. This has since been amplified by Dymock in his *Materia Medica of Western India*; by Sir D. Brandis in the *Indian Forester* of 1887; by the authors of the *Pharmacographia Indica* and by many correspondents in the Indian press. There are two kinds of *tabáshír* known in the bazárs, viz. *kabúdi*, blue; and *safed*, white; the former is only pale blue. It is largely used by Hindus and Muhammadans, and is considered cooling, tonic, aphrodisiac and pectoral. It is an ingredient in many compound medicines which are given in different lung diseases, but from its chemical composition it must be quite inert. Cohn (*Beiträge sur Biolog. der Pflanz.*, 1887, 365-406) may be said to regard it as the residuum of the water which fills the young joints. Sir David Brewster, in 1819, supported the opinion that the deposit within the stems was a consequence of disease set up by an insect. Brandis views (though incorrectly) the deposition as a natural process in the metabolism of

Two Kinds.

Agent of Formation.

Metabolism.

growth. [*Cf.* Garcia de Orta, 1563, *Coll.*, li.; Acosta (1578) in Clusius, *Hist. Exot. Pl.*, 259; Linschoten, *Voy.*, 1598, ii., 56; Piso, *Mant. Arom.*, in *Ind. Utri. re Nat. et Med.*, 185–7; Mandelslo, *Trav.*, *Ind.*, 1639, 149]

Edible Structures.

Fodder. **Medicine.** **Grain.** **Shoots.** **Pickles.**

Edible Leaves, Seeds and Shoots.—In the brief abstract of information given above as an alphabetical enumeration of the more important species of Indian bamboos, mention will be found of those that are specially valued as FODDER. Some are highly prized (especially for horses), others viewed as very indifferent fodders, and still others (such as *B. nana*) used mainly as cattle MEDICINES. It has already been stated that in times of scarcity bamboo GRAIN has saved the lives of thousands of human beings. Many instances are on record of the providential flowering of the bamboo in times of famine. The grain is pounded in the ordinary way in order to remove the husk, then milled until reduced to a coarse meal or flour. In that form, either by itself or after being mixed with rice or *juár*, it is baked into cakes (*chapatís*) and thus eaten. The young SHOOTS constitute a most important article of food all over India, nearly every bamboo being eaten in this stage; but the larger species are most generally used. Freed from the sheaths and hairs, they are cut up into small pieces and eaten in curries. They are also pickled or boiled into preserves. The young shoots of the smaller species if boiled in water with a little salt resemble an inferior quality of asparagus. [*Cf.* Nisbet, *Ind. For.*, 1895, xxi., 98–100; also Wallinger, xxvii., 226–8.]

Chemistry.

Chemical Composition.—The most complete analysis yet published of bamboo grain is that given by Prof. A. H. Church (*Food-Grains Ind.*, suppl., 1901, 6), which shows in 100 parts: water 13·5, albuminoids 10·8, starch 71·6, oil 0·6, fibre 2·1, and ash 1·4. "The above-stated percentage of albuminoids, calculated from the total nitrogen present in the grain, gives us the nutrient ratio 1 : 6·7, the nutrient value being 83·5." This was the result obtained from the examination of a sample of ***B. Tulda.*** Church adds that the grains were much larger than those of ***B. arundinacea*** though similar in chemical composition. Prof. T. Thomson of Glasgow found the ash of bamboo grain to consist of silica 90·50 per cent., potash 1·10 per cent., peroxide of iron 0·90 per cent., alumina 0·40 per cent., moisture 4·87 per cent., loss 2·23 per cent.

Manna.

Never seen before.

Manna.—In March 1900, Mr. A. E. Lowrie, Forest Divisional Officer, Chanda, sent me a sample of bamboo manna. This was chemically analysed at my request by Mr. D. Hooper and his results published in *The Agricultural Ledger* (1900, No. 17). Mr. Lowrie wrote as follows:—"About the middle of last month I went through the area of ***Dendrocalamus strictus*** seeded forests and found that, though most of the bamboo clumps were far advanced in seed, small stretches were still flowering, and strange to say, in the drier portions of the forest on poor soil, very stony and chiefly laterite. It was while passing through one of these tracts that I noticed the culms in the clumps streaked all the way down with what appeared to me to be a white brittle gum, similar to what one sees exuding from ***Odina Wodier.*** On asking some of the Gonds (local men) who were with me, what it was, they could not tell me and had never seen it before. I at once collected some, and on tasting it, found that it was perfectly sweet. The men then began collecting it by handfuls. I also collected some and send you a tinful in case you would care to have it. On reaching camp I got hold of a number of the villagers, both Gonds and others, and on inquiry they told me they had never seen or heard of this gum. I passed through a number of similar stretches in which the bamboos were covered with the gum. This sugary deposit only extended for about five feet along the culms and was entirely absent towards the tops; it was found both at the nodes of the bamboo as well as on the stems between the nodes. I am sure this has nothing to do with any insect deposit, nor has it been caused through the aid of insect punctures in the stem of the bamboo, as I made a careful examination of a number of culms. The culms also were old ones, one, two and three years old." Mr. Stebbing, however, reports that he had found the leaves of ***Bambusa arundinacea*** so attacked by an Aphis as to cause a manna to fall in drops on the stems. Hooper found that the manna furnished by Mr. Lowrie consisted of a saccharose related to, if not identical with cane-sugar. [*Cf.* with *Hobson-Jobson* (ed. Crooke), 863.]

Timber.

Timber.—Bamboos form the most important portion of the minor forest produce of all forest divisions, and one that increases in value every year. Gamble estimates that the Indian annual consumption of bamboos must be something like 150 millions per annum. The forest administration Annual Reports issued by the various provinces of India afford useful particulars as to the supply drawn from their respective producing areas. It would occupy a volume to enumerate even by name all the uses to which the mature bamboo stems are put. To the inhabitants of the regions where the bamboo luxuriates, it affords all the materials required for the erection and furnishing of ordinary dwelling-houses. Certain species are more serviceable for posts, others for matting and basket-work, etc., etc., but if one or two species be used every requirement in house construction and furnishing may be met. Perhaps one of the most curious is the employment of specially prepared slips of bamboo for the purpose of letter-writing. M. Chavannes (*Les Livres Chinois, etc.*) has shown that in ancient times (or prior to the discovery of the art of paper-making in 105 A.D.) the stationery of China was mainly of this nature. Stein (*Ancient Khotan*, 1907, 358) has moreover shown that the oldest manuscripts discovered by him (3rd century) were written on specially prepared pieces of wood made up on the pattern of the older bamboo slips (see under **Leather**, p. 636; also **Paper and Paper Materials**, p. 862). The reader had better also consult the account of the economic uses of the Bamboo as given in the *Dictionary*.

Annual Consumption.

House-construction and Furnishing.

D.E.P., i., 394-9. Barilla.

BARILLA, or SAJJÍ KHAR; Ball, *Man. Econ. Geol. Ind.*, 1881, 492-5; *Kew Bull.*, 1890, 56-62; *Agri. Ledg.*, 1902, No. 5, 126; Holland, *Rec. Geol. Surv. Ind.*, xxxii., 115.

A century ago the manufacture of carbonate of soda from the ashes of certain saltworts was an important industry. Attention was accordingly early directed to India as a source of supply for Great Britain to supplement that obtained from Spain. Roxburgh, Royle, Baden-Powell and many other writers in succession described the existing trade and discussed its possible developments. Roxburgh (*Fl. Ind.*, ii., 61) practically speaks of the future of the Indian barilla trade as being of national importance. He explains that one species of ***Salicornia***, one of ***Arthrocnemum*** and one of ***Salsola***, which are extremely abundant plants on the Coromandel Coast, might be made to yield barilla sufficient to make SOAP and GLASS for the whole world, since labour is cheap and population abundant. That opinion was written before the date of the famine that removed fully half the labouring classes of Coromandel (1791-3). It need hardly be said, however, that the discovery of Le Blanc's method of preparing sodium carbonate chemically from common salt not only destroyed these and all other similar expectations of a remunerative trade in barilla, but

Barilla. World's Supply.

Soap and Glass.

Expectations Falsified.

revolutionised the world's necessities and demands for the salt. At the present moment were the available lands not only of Coromandel but of all similar suitable tracts in India to be devoted exclusively to the production of barilla, they probably could not supply a tithe of the present demands for sodium carbonate.

Panjáb Production.

Baden-Powell (*Pb. Prod.*, 1868, i., 86) gives an instructive account of the barilla industry of the Panjáb. Very little of importance has since been written on this subject and the following abstract may, therefore, be taken from that work:—"The process by which this substance is prepared is carried on during the month of October and three following months. The plant after being cut down is allowed to dry. The next step is to dig a pit of a hemispherical shape, about 6 feet in circumference and 3 feet deep. One or more vessels with holes perforated are inverted and placed in the bottom of the pit, the holes being kept closed until the alkali begins to flow, when they are opened by a stick previously arranged for that purpose. The dry plants are gradually burnt, and during the process a liquid substance is found to run down into the inverted vessels. After this has taken place, the residue is stirred up by means of a flat piece of wood and kept covered over for three or four days till it cools. Care must be taken not to allow water to get to the molten liquid, otherwise the whole mass would blow up. In the inverted vessels will be found a pure form of *khár sajjí* (sometimes called *lota* (pot) *sajjí*) and in the bottom of the pit an impure form containing a mixture of ashes."

Khár Sajji.

Multán.

In the *Dictionary* more recent papers are reviewed. The Deputy Commissioner of Multán says that in that district the plants are collected in January and February. He then observes that the land on which barilla-yielding plants grow was in 1883–4 leased for Rs. 7,907. The Settlement Report of Shahpur District contains an interesting account of the barilla industry in which it is stated that the farming of the monopoly fetches upwards of Rs. 8,000 a year. The quantity of *sajjí* manufactured is said to be about 10,000 maunds. In Montgomery and Jhang the *khár* (or *khangan khár*) plant is ***Haloxylon recurvum***, and this is supposed to yield the finest quality of *sajjí*; the inferior qualities are believed to be made from the various species of *laná*, of which the *gora laná* is the best (***Salsola fœtida***).

Montgomery and Jhang.

Sind.

In Sind the plant that yields the best *sajjí* is said to be known as *laní*. This grows wild all over the province and springs up spontaneously after a copious fall of rain. The process of manufacture pursued in Sind differs from that described in connection with the Panjáb in the circumstance that earthen pots (*lota*) are not employed. The industry flourishes most at Kutchi in Khelát, where over 5,000 maunds are annually prepared. In Shikárpur a like quantity is made, and in Thar and Parkar about 3,000 maunds are annually turned out.

Extent of Trade.

Aden.

There seems also to exist a fairly extensive manufacture of sodium carbonate at Aden from the so-called *Aden Balsam* (? ***Sueda nudiflora***).

The publication of the article "Barilla" (in the first volume of the *Dictionary*) led to a correspondence on the subject of a possible extension of the industry. In 1888 the Madras Government asked the assistance of the Director of Agriculture in the Panjáb. The result was that Mr. J. R. Drummond, then Deputy Commissioner of Karnál, was invited to draw up a report on the Panjáb saltworts actually in use in the manufacture of barilla, and this was furnished to the Madras Government. After considering the information procured from various sources, the conclusions arrived at by the Government may be put thus:—

Madras Opinion.

1. It was cheaper and more convenient to obtain sodium carbonate from alkali deposits in the soil (such as the well-known *dhobi's* earths of various parts of the Presidency) than to burn saltworts and manufacture barilla.
2. The imported pure salt could be had at such a low price that it was doubtful whether either method was likely in the future to compete successfully.

Indian Saltworts.

List of Chief Plants.

The following may be given (in continuation of the observations under **Alkali Soils—Réh**, p. 51) as an alphabetical enumeration of the better known saltworts of India, in which all those that might be successfully tried in reclamation of *réh* efflorescence have been shown, as well as those actually employed in the manufacture of barilla.

Arthrocnemum indicum, *Moq.* The *jadu palang, machola, ghuri, chil, umari, koia-pipail*—a native of the salt marshes of Bengal, Madras and Bombay. D.E.P., i., 328.

D.E.P., i., 349 51. **Atriplex repens,** *Roth.* A shrubby plant found on the coast of South India and the Deccan. Experimented with unsuccessfully in Madras as a source of barilla. ***A. Stocksii,*** *Boiss.,* a shrubby species (*juri*) common in the salt marshes at Karachi and fairly common in Gujarat. [*Cf. Agri. Journ. Ind.,* ii., 167.]

Halocharis violacea, *Bunge.* A small diffuse annual common in the Peshawar Valley, Western Panjáb, Salt Range, and Baluchistan.

D.E.P., iv., 199. **Haloxylon recurvum,** *Bunge.* The *khár, khári-lani,* etc.—a straggling bush plentiful in the C. and W. Panjáb plains and Salt Range, also found in Sind, Deccan (Coimbatore) and Burma. This is the most important barilla-yielding species. ***H. multiflorum,*** *Bunge,* and ***H. salicornicum,*** *Bunge;* the former occurs in the Panjáb and the latter in Sind. They seem to be used as adulterants or substitutes for ***H. recurvum.*** [*Cf. Agri. Journ. Ind., l.c.*]

D.E.P., iv., 567. **Kochia indica,** *Wight. Bui, kaura ro*—a herbaceous plant which occurs from Delhi to the Indus and also in the Deccan (Coimbatore). [*Cf. Agri. Journ. Ind.,* ii., 167.]

D.E.P., vi., pt. ii., 387. **Salicornia brachiata,** *Roxb.* The *quoilu, umari-kirai*—a small shrub found on most salt marshes in Bengal, South India (Tanjore), etc.

D.E.P., vi., pt. ii., 392. **Salsola fœtida,** *Del.* The *laná, shora* (*shorga*), *lanan, ella-kura,* etc.—a saltwort much valued as fodder for camels and employed in the *Hari-rúd* in the Panjáb from Peshawar Valley south-westwards.

D.E.P., vi., pt. iii., 386. **Suæda fruticosa,** *Forsk.* The *lunak, choti-laní, limch, ushak laní*—a sub-erect shrub of N.W. India throughout the Panjáb. Used mainly as an adulterant in barilla. ***S. monoica,*** *Forsk.*—a shrubby species met with on the coast of the S. Deccan. ***S. nudiflora,*** *Moq.*—*morasa, khári-láni, geria, kiray, rava kada,* a shrub met with on the coasts of Bengal, Bombay and S. India. ***S. maritima,*** *Dumort.*—*laní, khári-laní, laná, yella kiray, ila* or *ella-kura.* A herbaceous species (occasionally shrubby) met with in the Upper Gangetic plains from Delhi to the sea-coasts of Bengal, Bombay and the Deccan. The leaves are eaten, especially in times of famine. Drummond says that most references by authors to ***S. nudiflora*** should be taken as denoting this plant. [*Cf. Kew Bull.,* 1891, 96-7.]

For information regarding exotic drought-resisting plants in India confer with paper by Sly in *The Agricultural Journal of India* (ii., pt. ii., 161–70).

D.E.P., i., 404 5. Baskets.

BASKET AND WICKER-WORK, also Braiding, Hat and Fan Manufacture;

Mukharji, *Art. Manuf. Ind.,* 1888, 307–14; *Ind. Art at Delhi,* 1903, 220; Gee, *Monog. Fibrous Manuf. Pb.,* 13-4.

The above heading embraces several distinct crafts, but since the materials employed are often identical, collective treatment may perhaps be the most satisfactory. The opening paragraph of the article **Bamboos** has already set forth some of the leading ideas that prevail, such as the separation of the Bamboos (***Bambuseæ***) from the Canes (***Calamus***) and from the Reeds. But there remains the even more difficult task of designing a classification for the basket materials that are neither reeds nor canes, and for the matting materials that are often grasses, reeds, canes or even bamboos. It is proposed to get over this difficulty by furnishing in this work several articles that conjointly may embrace the whole of these somewhat diversified crafts and materials. These will be (*a*) Bamboos: (*b*) Calamus: (*c*) Basket and Wicker-work—the reeds for the most part: (*d*) Cyperus or Grass-Matting: and (*e*) Mats and Matting. But over and above these collective articles, certain substances that have other and more important uses than as materials for baskets and mats will be discussed in their own alphabetical positions, and references to these are accordingly given in the collective articles so that the reader may have little difficulty in discovering the products necessary to complete special enumerations.

Throughout India basket-making in some form is practised, and very largely so by the gipsy class. In the rural districts it is of the crudest possible kind, the baskets produced being intended purely and simply for agricultural purposes. Here and there, however, basket-making, as a consequence of special materials and facilities, attains a fairly high position, and in one or two instances even becomes artistic and ornamental. The following may be mentioned as the chief materials used and the centres of their utilisation, taken up in the alphabetical sequence of the scientific names of the plants concerned:—

Acacia arabica—Agricultural baskets (see p. 8).

Alnus nitida.—The *alder* or *shrol*, *udish*, etc., twigs used in tying loads, in construction of rope-bridges and of crude baskets.

D.E.P., i., 175–7.

Arundinaria *spp.* (see **Bamboos**, p. 99).

Bambusa, etc. (see **Bamboos**, pp. 99–101 *et seq.*) Along the foot of the Himalaya from east to west, bamboo basket-making is an important industry. The combined hat and umbrella of the Assam and Burmese cultivators, as also the highly artistic hats of the Shans, are made of bamboo. In Bengal, ingenious and often neatly constructed fish-traps and bird-cages are also constructed of bamboo. The traffic in these articles is by no means insignificant.

Borassus flabellifer.—Fancy baskets, etc. (see p. 170).

Cajanus indicus.—Agricultural baskets (see p. 200).

Calamus (see pp. 201–4.) Cane baskets of great strength are largely produced in Bengal, as for example in Patna, Pubna, etc. These are formed of entire canes wound round and round and held in position by tie-bands. Fancy cane-work is largely produced in Poona, Ratnagiri, Kanara, etc. In Bengal a small colony of Chinamen are engaged in the production of cane-chairs, baskets, etc. In Shimoya in Mysore and in several localities in Coorg cane-work of some note is turned out.

Caryota urens (see p. 286).

Corypha umbraculifera (see p. 429).

Dendrocalamus (see **Bamboos**, p. 102).

Indigofera atropurpurea.—The *bankati*, *sakuan*, and **I. Gerardiana**, the *kati*, *khenti*, etc., are fairly extensively employed by the hillmen to tie loads and make baskets, etc.

D.E.P., iv., 384–5.

Melocalamus compactiflorus.—The bamboo most highly prized for lacquered boxes and trays (see p. 103).

Parrotia Jacquemontiana.—The *psher* or *pishor*, *killar*, *spilecha*, etc., of the N.W. Himalaya, is a most useful shrub, the twigs of which are extensively employed in binding loads, making strong (though not very durable) baskets and in constructing the so-called rope-bridges (*jhulas*) which are thrown across the mountain torrents. Occasionally twigs of ***Cotoneaster***, ***Indigofera***, ***Olea***, and ***Salix*** are mixed with ***Parrotia***, and in other parts of the Himalaya the grass ***Ischæmum*** is mainly used for these bridges.

D.E.P., vi., pt. i., 111.

Phœnix (see pp. 884–5). Beautiful cigar-cases are plaited in Madras from specially prepared strips of the leaves of this palm. The leaves, which are known as *bhutra* or *khushab*, are also woven or plaited into fans, baskets and ropes, etc. The leaf-stalks (*chhari*) make excellent walking-sticks, and split up they furnish a material which is woven into exceedingly strong crates and baskets. W. H. Gee (*l.c.* 15) says that in the Panjáb the manufacture of fans from the date-palm is universal, and that there is a fair export in these articles from Peshawar. Fans are made largely in Rohtak and Karnal. In Delhi also there are two factories for date-palm fans. The leaf is soaked in water for a short time and some of the leaflets cut off and plaited in with those that remain, thus forming the fan. They are then stained according to certain patterns. A man can make about twelve such fans a day. In most parts of the country where one or other of the date-palms is plentiful the leaves are largely employed in the construction of baskets, as a rule in the bee-hive shape. These are produced in the Madras and Bombay Presidencies and in the Panjáb, Sind, Baluchistan and Afghanistan. In the eastern parts of Bengal, matting used in houses is almost always of *khajúr* (***Phœnix***) and is sold at about Rs. 6 per 100 square yards. [*Cf.* Gee, *l.c.* 6, 14.]

Cigar-cases.

Crates.

Fans.

Baskets.

Matting.

Phragmites (see **Mats and Matting**, p. 777).

Pseudostachyum (see **Bamboos**, p. 104).

Rhus Cotinus.—The Elm-leaved Sumach or *tinga*, *phan*, etc.; shoots employed in coarse basket-making.

D.E.P., vi., pt. i., 498.

Saccharum arundinaceum (see **Munj**, pp. 929–30).

Salix.—Several species of Willow. There does not appear to be in India any generic name like osier which denotes the specially grown shoots used in basket-making, but *bed* or *bent* are very general names, and others such as *bin*, *bis*, *bisa*, *bhesh*, *baish*, *bhains*, *bes*, etc., all denote willows. Although never so successfully worked up as in Europe, the willows of India are of the greatest possible value to the people. The *kiltas* or load-baskets carried on the back by the hillmen are very generally made of willow, and the long willow-baskets used in conveying apples and pears from Kullu and Kashmir to the plains are well known. The *kilta* is a pointed basket so

D.E.P., vi., pt. ii., 387–91.

Kiltas.

Chairs.

designed as to throw the chief weight on the shoulders. In some of the jails and asylums of India admirable willow baskets and chairs are now produced, but this is apparently a modern industry. Willow twigs, when procurable, are largely used in all rural parts of the country for wattles, weirs, dams and fences. The bark is often stripped off the twigs and used in place of string, the twigs being then converted into charcoal, which is viewed as of special merit.

D.E.P., vi., pt. iii., 402.

Tacca pinnatifida.—The *dhai, diva, periya, kanda, kanli-kund, touk-ta,* etc. An investigation recently conducted at the Imperial Institute into the possibility of this plant being used as a braiding material, resulted negatively. But the tubers are fairly extensively eaten by the hill tribes of Chota Nagpur and the Central Provinces. [*Cf.* Forster, *Pl. Esc.*, 1786, 59; Rumphius, *Herb. Amb.*, v., t. 114; Nicholls, *Excise Rept. C. Prov.*, 1878–9, app. D.]

D.E.P., vi., pt. iii., 409 13.

Tamarix.—The *jau* affords long flexible twigs that are very generally employed in the manufacture of baskets, brooms and wattles, especially in South Panjáb. Stein (*Ancient Khotan*, 1907, 332 *et seq.*) makes repeated reference to the tamarisk as seen in the ruins of Khotan, the specimens being found in association with other objects of date 3rd to 8th centuries. Wattle mattings of tamarisk plastered over were one of the chief methods of forming partitions in house-construction. The pens used by these ancient peoples were also made of tamarisk wood.

D.E.P., vi., pt. iv., 88 202.

Straw Baskets.

Triticum, also **Oryza** and other straws are worked up into fancy baskets, as for example in Hazara and Nepal. W. H. Gee (*l.c.* 14) observes that the wheat-straw baskets of Hazara are of two kinds, viz. *mandhas* and *parotas*. "The former cylindrical and narrow at the base, the latter with straight sides; both are often worked in coloured designs and cost from Rs. 0–4–0 to Rs. 1." Collins (*Arts and Manuf. Beng.*, 1890, 6) says that "in the Patna and Bhagalpore Divisions fancy baskets of coloured grasses are made by high-caste ladies. . . . Fancy straw baskets are made in Purneah district. Leghorn hats are made of the straw of spelt wheat (see p. 1084).

Typha (see **Mats and Matting**, p. 777).

Vetiveria zizanioides.—The *khas-khas* (see p. 1106).

[The following special works may be consulted in amplification of the particulars here given regarding basket-ware:—Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 72–5; Kipling, *Ind. Pb.*, in *Journ. Ind. Arts*, 1885, i., 80; Lawrence, *Valley of Kashmir*, 1895, 250, 372; Stuart, *Man. S. Kanara*, 1895, ii., 149: *Kew Bull.*, 1899, 200; James, *Basket Makers of California*, 1901; O. T. Mason, *Smithsonian Inst. Ann. Rept.*, 1902, 185–548 (plates 10 to 248); etc., etc.]

D.E.P., i., 405 6.
Butter Tree.

BASSIA BUTYRACEA, *Roxb.*, *As. Res.*, 1805, viii., 477–85, with coloured plate; also *Fl. Ind.*, ii., 527; Traill, *Proc. Roy. As. Soc.*, 1838, 115–7; Gamble, *Man. Ind. Timbs.*, 448; *Fl. Br. Ind.*, iii., 546; SAPOTACEÆ. The Indian Butter Tree, *phulwárá, chiura, chára, cheuli, chúri, yel,* etc. The butter is called *chiura-ke-pina, phalel* or *phulwa*. A large deciduous tree of the Sub-Himalayan tracts from the Ganges to Bhutan, ascending to altitudes of 15,000 feet.

D.E.P., i., 406-15.
Mahua.

B. latifolia, *Roxb.*, *Pl. Coro. Coast*, i., 20, t. 19; also *Fl. Ind.*, ii., 526; Chas. Hamilton, *As. Res.*, 1788, i., 300–19; Jones, *As. Res.*, 1795, iv., 285; *Taleef Shereef* (Playfair, transl.), 1833, 161; Elliot, *Fl. Andh.*, 1859, 70; Gibson, *Hooker's* (*Kew*) *Journ. Bot.*, 1853, 90; Dymock, *Mat. Med. W. Ind.* (2nd ed.), 476–9; Campbell, *Econ. Prod. Chota Nagpur*, No. 8401; *Pharmacog. Ind.*, 1891, ii., 354–62; Forsyth, *Highlands of Central India*, etc. (2nd ed.), 75; G. M. Ryan, *Comm. Value of Mhowra Seeds*, in *Ind. For.*, 1903, xxix., 543–9; Cooke, *Fl. Pres. Bomb.*, ii., 92; *Rec. Bot. Surv. Ind.*, ii., 115; *Fl. Br. Ind.*, iii., 544; *Agri. Ledg.*, 1899, No. 12. The Mahua, Mahwa or Mowha Tree, *mahúa, moha, mhova, matkom, mohul, mahu, moho, irpi, irhu, ippa, yeppa, illupei* (*illupai*), *hinge, punam, kanzaw*, etc., etc. A large deciduous tree of the forests of the central tracts of India from Western Bengal, Oudh and Kumaon to Gujarat, Kanara and Burma. It ascends the hills to altitudes of close on 4,000 feet and is often cultivated.

B. longifolia, *Linn.*; Gaertner, *Fruct. et Sem. Pl.*, ii., t. 104; Lamk., *Illust.*, t. 398; Roxb., *Fl. Ind.*, ii., 523; Wight, *Illust. Ind. Bot.*, ii., t. 147; *Rec. Bot. Surv. Ind.*, ii., 183; Gamble, *Man. Ind. Timbs.*, 448; Cooke, *Fl. Pres. Bomb.*, ii., 92; *Fl. Br. Ind.*, iii., 544. This evergreen tree is met with from the Konkan southwards and replaces *B. latifolia* in South India. It is most frequently met with in cultivation. The Tamil, Telegu and other South Indian names mentioned above more especially refer to it, such as *ippa*, *yeppa*, *pinna*, *illipi*, *ippi*, *hippe*, *mi*, *meze*, etc.

D.E.P., i., 415-6. South Indian Mahua.

B. malabarica, *Bedd.*, *Forester's Manual*, 140; Talbot, *List Trees, etc.* (2nd ed.), 207; Woodrow, in *Journ. Bomb. Nat. Hist. Soc.*, 1898, v., 163; Cooke, *Fl. Pres. Bomb.*, ii., 93. A tall tree of the Western Ghats from Kanara to Travancore and the Anaimalais, ascending to altitudes of 4,000 feet. It is best known by the names *att-illupei*, *udlu*, etc.

D.E.P., i., 416. Western Ghats Mahua.

Wild, also Semi-cultivated.

Habitat.—The *mahua*, though met with in a purely wild state in many parts of India, is of the greatest possible value to the inhabitants of large tracts of country where it exists in a state of semi-cultivation. It prefers dry sandy and even rocky soil to rich low-lying and inundated lands. Apparently it is self-sown, the seedlings being in some parts of the country protected for a few years (*Ind. For.*, 1880, v., 468). But by the casual visitor, it would appear, seedlings are not readily detected. Hamilton in 1788 (*l.c.* 305) says that neither he nor any of his friends had ever seen an infant plant. Several writers have recorded the same observation. Mr. Sly (Commissioner of Settlements and Agriculture in the Central Provinces) does so in his Annual Report for 1902-3, and adds that in the absence of reproduction it is only a question of time for many villages to lose a most valuable addition to their food supplies. Numerous writers deplore the disappearance of the tree from regions where it formerly grew. Others urge, and with much force, that every effort should be made to extend rather than to contract its cultivation. As a protection against famine few schemes are to be more highly commended (for many parts of India) than systematic cultivation of *mahua* where suitable lands are available.

Paucity of Seedlings.

Disappearance.

Extended Production Desirable.

History.

History of Mahua.—It seems highly probable that the economic information published from time to time regarding the *mahua* tree is fully applicable to all the above-mentioned species, each in its own area being the *mahua* or *illupei* of popular writers. From the industrial standpoint there is in fact no very sufficient reason for their different values. The most remarkable fact regarding the *mahua* is that it appears to have escaped the notice of all the early European travellers—Marco Polo, Vasco da Gama, Garcia do Orta, Varthéma, Linschoten, Tavernier, Rheede and Rumphius are silent regarding this most valuable tree. It was, however, well known to the classic authors of India. Its best-known Sanskrit name is *madhuka*. Susruta describes the spirit obtained by the distillation of the flowers, and the oil from the seed is mentioned by Chadradatta. Ibn Batuta, who travelled in India in 1332, calls it *mahwa* and remarks that the sun-dried flowers taste like figs (Dymock). In the *Memoirs of the Emperor Baber*, written from 1494 to 1529 (Leyden and Erskine, transl., 1826, 325), the *mehweh* or *gal-chekan* is said to be a wide-spreading tree of whose timbers the houses of the Natives of Hindustan are chiefly constructed. Mention is also made of the spirit extracted from the flowers, of the dried flowers eaten like raisins, and of an oil extracted from the kernel. Thevenot (*Travels Levant, Indostan, etc.* (Engl. transl.), 1687, iii., 94), speaking of Golconda, tells us that clumps of a tree called "*Mahoua*" were placed along the boundary of the territory of the "Mogul." The *Ain-i-Akbari*, 1590 (Blochmann, transl., 70), refers to it as yielding a fruit known as *gilaundah*, which Abul Fazl adds is employed in the preparation of an intoxicant. The botanical and other writers mentioned above in connection with each species, carry the history of the products of these plants up to the most recent dates, and it may be added that only the more important, and especially those not mentioned in the *Dictionary*, have been quoted,

Sanskrit Knowledge.
Spirit.
Oil.

Baber.

Akbar.

Food.
Gum.
Dye.
Medicine.
Timber.

Economic Value.—It may be said that there are two great products of the tree, (*a*) the EDIBLE FLOWERS and (*b*) the OIL-yielding seeds. The *Dictionary* should be consulted for the minor uses, and these may therefore be disposed of here very briefly. A GUM or gutta (the milky sap hardened) flows from incisions or abrasions on the stem (see p. 627). [*Cf. Pharmacog. Ind.*, ii., 358–60 and 361 for its chemical properties and uses.] In some parts of the country ringing of the stems is practised just on the setting of the fruits. When this is done the gum may be obtained in abundance. The bark is employed as a DYE. The flowers, the oil, the spirit distilled from the flowers, and the bark are all used MEDICINALLY. Lastly the TIMBER has some merit, but the trees are, as a rule, too valuable to allow of their being killed for this purpose.

Flowers.
Seasons.
Yield.
Preparation.
Method of Cooking.
Sugar prepared from.
Consumption to Population.

The Flowers.—The *mahua* shows its leaves from February to April. The cream-coloured flowers appear as great clusters (of 30 to 50) near the ends of the branches, from March to April, and are soon followed by the young leaves. Preparatory to the harvest of flowers the people clear the ground below the trees by burning the weeds and smoothing the soil. About March the flowers begin to come to maturity, and every morning just after sunrise the succulent corolla-tubes fall in showers to the ground. This continues till the end of April, each tree yielding from 2 to 4 maunds of flowers, but usually the fall from a single tree is complete in about 7 to 10 days. Mukerji (*Handbook Ind. Agri.*, 291) says the yield of each tree is from 5 to 8 maunds. A drying-floor is prepared in a position central to a selected batch of trees. The ground is smoothed and beaten, etc.; on this the flowers as collected day by day are spread out to dry in the sun. In a few days they shrink in size, change in colour to a reddish-brown, and their peculiar sweet smell becomes more concentrated and its resemblance to that of mice more intense. But the *mahua* that is intended for sale is not dried to the same extent as that set apart for home consumption, and naturally so since the loss in weight is considerable. But *mahua* is eaten extensively while fresh—in the dried form it is cooked and eaten along with rice and other grains or food materials. Before being eaten the dry corolla tubes are beaten with a stick to expel the stamens (*jili*); the quantity required is then boiled for six hours or so and left to simmer until the water has been entirely evaporated and the *mahua* produced in a soft juicy condition. Tamarind or *sál* seeds and gram are frequently eaten along with *mahua*. By the better classes it is fried with *ghi* (butter) or with *mahua* oil. It is extremely sweet, but the power to eat and digest this form of food is an acquired one, so that few Europeans are able to consume more than one flower without having disagreeable after effects. Sometimes the *mahua* is dried completely, reduced to a powder, and mixed with other articles of food. In that condition it is often baked into cakes. Sugar may also be prepared from the flowers or they may be distilled and a wholesome spirit prepared, the chief objection to which is its peculiar penetrating smell of mice Nicholls estimated that in the Central Provinces 1,400,000 persons use *mahua* as a regular article of food, each person consuming one maund per annum—an amount that would set free about 1½ maunds of grain or about 30 per cent. of the food necessities of the people in question. This at the lowest estimate comes to one quarter of a million pounds sterling which the tree presents annually to these provinces. It would serve no purpose to speculate as to the corresponding total supply for all India; the above illustration of one province exemplifies its extreme value.

Price.

Mahua, in times of abundance, may be purchased at a very small figure, but normally it costs about 12 annas a maund. As a rule the surplus over local necessities is sold. The chief purchasers are the distillers, and the additional revenue thus derived greatly enhances the value of the tree. Some few years ago the experiment was attempted in Bombay of the Forest Department becoming the vendors of the available surplus and selling to the trade. The object in view was the protection of the poor and ignorant people, who it was believed often got but a fraction of the actual value of their produce. At that time also there was a fairly brisk new export trade in *mahua*, which went apparently to Europe to be used for distillation. It is generally believed that the action of the French Government in closing their ports to *mahua* ruined the foreign traffic and accordingly the exports shrank to small proportions, the article being at present exclusively used in Europe to feed pigs—a purpose recommended originally by E. Lockwood (*Journ. Linn. Soc.*, xvii., 89).

European Uses.

Spirit.

Adulteration of.

Early Accounts of.

Mahua Spirit.—As already indicated, the art of distilling these flowers is a very ancient one in India. Susruta mentions *mahua* spirit. The *Ain-i-Akbari* alludes to it. Hove (who travelled in Bombay in 1787, 142) tells us that the *mawra* (as he calls it) affords when distilled a pure and very pleasant but remarkably strong spirit. This he observes is often poisoned with ***Datura***, and accordingly he concludes, "I would advise the Company to send out orders to their Settlements to inspect the common liquors more minutely and they would not lose half the troops which they commonly do on this side of India." Williamson (*East Ind. Vade Mecum*, ii., 153) tells us that in 1810 the number of shops for the sale of mahua and other spirits was "absolutely incalculable." Thus India had little to learn from Europe either in the art of distillation or in the habit of alcoholic consumption. The registration and supervision of the traffic which had been inherited by the Company and by the Crown became a necessary evil.

One of the best accounts of *mahua* spirit is that by Archibald Keir (*As. Res.*, 1788, i., 309–19). That article was written in Chatra in Ramgar after a most careful personal study of the subject. Dr. Gibson (*Hooker's* (*Kew*) *Journ. Bot.*, 1853, v., 90) tells us that in Gujarat and Rajputana every village has its spirit-shop, and he adds that the Government duty on the spirit distilled at Caranja, opposite Bombay, came to something like £80,000. He then observes that the spirit prepared was something like Irish whisky but had a strong smoky and rather fœtid flavour.

Its Aroma.

Yield.

The aroma is the chief disadvantage to the spirit, but it is understood that a gentleman who experimented in Monghyr very extensively with this issue, succeeded in producing a spirit quite free from the objectionable smell. Lockwood tells us that he had ascertained that six gallons of spirit could in Europe be produced from one hundredweight of *mahua*. More recently it has been found that as much as 7·6 gallons per cwt. can be produced, the yield from molasses being only 5½ gallons, and much less from barley, potatoes, etc. [*Cf.* Manson, *Journ. Agri.-Hort. Soc. Ind.*, 1886, vii., 83–5.] He tells us that the spirit is called *daru* and much resembles Hollands both in appearance and taste, but unfortunately it retains the sickening flavour of the flowers. The method of distillation is similar to that pursued in all other countries, save that in India it is less scientific and correspondingly more wasteful (see **Eleusine**, p. 521). For preparation of vinegar from *mahua* flowers, see p. 1109.

Mahua Butter.

The Seed, Oil and Butter.—From the remotest antiquity it has been known that the seeds of this plant contain a large quantity of an exceedingly good edible oil, which owing to the ease with which it solidifies is often called MAHUA BUTTER. The oil from ***B. butyracea*** is generally upheld as more valuable than that of the other three species, chiefly because it solidifies almost immediately after being expressed from the seeds. Roxburgh (*As. Res.*, viii., 477–85) has given a full account not only of the butter of ***B. butyracea*** but of the oil of ***B. longifolia***, the last mentioned being from the pen of the Rev. Dr. John. In the *Journals of the Agri. Horticultural Society of India* numerous papers have appeared urging the desirability of an extended production and use of these oils (1848, vi., 219–22, also app. lxix, cxiv.; 1861, xii., 345, n.s.; 1869, i., 394–7; 1886, vii., 76–92; etc). Instructive and useful are also the articles by Lockwood in the *Journal Linnæan Society* (1878, xvii., 89); in the *Dictionary* (1885, i.); in *The Agricultural Ledger* (1899, No. 12); and in Mukerji's *Handbook of Indian Agriculture* (1901, 290–1), which carry the subject up to the most recent and very admirable paper by G. M. Ryan (*Ind. For.*, 1903, xxix., 543–9). This, among other features of interest, sets forth particulars of a new trade that seems of growing value to India. The seeds (nuts), he observes, are commonly known as *mohoti*, and are collected about the end of May to beginning of June. There is a considerable local demand for them all over the country, but apparently a practical margin for export is annually available. Ryan puts the price of the seeds at Rs. 4¼ per cwt., which shows a net profit to the trader of 13 annas. During the past five or six years the foreign traffic has rapidly expanded, and stands now at about 500,000 cwt. It would seem that these nuts are consigned to Hamburg and Antwerp, and the supplies are drawn from Bombay, Rajputana, Central India, Central Provinces and even the United Provinces. A difficulty would appear, however, to exist in Europe in the disposal of the cake, which in India is used as a manure. [*Cf.* Leather, *Agri. Ledg.*, 1897, No. 8, 23.]

Seeds or Nuts.

Oilcake.

Oil.

The oil of the *mahua* proper (not *mahua* butter) is greenish-yellow, and is largely eaten all over India, and in addition is used to adulterate *ghi*. It is sometimes called *doló* oil. In South India the solid form is called *illipi* butter. Here and there a fair quantity of soap is made from this oil. The oil is also largely burned by the hill tribes, who express it crudely from the seeds. Apparently the only limitation to the uses of the oil is the want of enterprise in its extended production.

Soap.

D.E.P., i., 419–26.

BAUHINIA, *Linn.*: *Fl. Br. Ind.*, ii., 275–84; Gamble, *Man. Ind. Timbs.*, 280–5; *Pharmacog. Ind.*, i., 536–7, 549; Cooke, *Fl. Pres. Bomb.*, i., 430–4; Duthie, *Fl. Upper Gang. Plain*, i., 297–301; LEGUMINOSÆ. A genus of arborescent or scandent plants diffused throughout the tropics. Out of 130 species which have been described, 30 are Indian; those enumerated below are, therefore, the species of economic importance.

Indian Economic Species.

B. anguina, *Roxb* The *nag-pút*, *naiwilli*, *suhatúngrnugrik*—a climber of N. and E. Bengal, Sikkim, Chittagong, Martaban, Burma and South India, etc.

B. macrostachya, *Wall.* The *gunda-gilla*—an extensive climber found in the forests of Sylhet and Assam.

B. malabarica, *Roxb* The *amlí*, *karmai*, *gourubati*, *laba*, *amli-taki*, *kattra*, *cheppura*, *korala*, *kundapula*, etc—a bushy tree met with in the Sub-Himalayan tract, from the Ganges to Assam, and in Bengal, Burma, and South India.

B. purpurea, *Linn.* The *koiral*, *koliár*, etc.—a moderate-sized deciduous tree of the Sub-Himalayan tract from the Indus eastward, also of Central and South India and Burma.

B. racemosa, *Lam.* The *kachnál, banraj, kaimu, katmanli, areka, ari, asotri, aupta, palan*, etc.—a small crooked tree met with in the Sub-Himalayan tract from the Ravi eastwards, in Oudh, Bengal, Burma, and Central and South India.

B. retusa, *Ham.* The *kurál, kandla, laba*, etc.—a moderate-sized deciduous tree of the N.W. Himalaya from the Beas eastward, to Simla, Garhwal, Kumaon and Central India.

B. tomentosa, *Linn.* The *kachnár, asundro, chámal*, etc.—an erect shrub met with in the U. Provinces, and throughout India to Ceylon and Penang.

B. Vahlii, *W. & A.* The *malghán, chehur, sihár, borla, sungurg rik, jom, lama, shioli, maulan*, etc.—one of the most useful of Indian climbing Bauhinias. It is found all along the lower Himalaya from the Chenab eastward, in N. and C. India and Tenasserim. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1904-5, 28.]

B. variegata, *Linn.* The *kachnár, koliar, rakta kánchan, kurmang, singya, kundol, taki, kovidara, bwéchin*, etc.—a moderate-sized deciduous tree found in the Sub-Himalayan tract from the Indus eastward and throughout the forests of India and Burma. It is largely cultivated in the plains as an ornamental tree.

Gum.

Most of the species yield a GUM which seems to be known by a generic name, *sem-ki-gónd*. It is as a rule too little soluble in water to be of great value. That from ***B. retusa*** (*semla gónd*) is very like gum arabic. It is eaten by the poorer classes and is used to waterproof terraced roofs, and also medicinally as an external application to sores. By some Native practitioners it is regarded as emmenagogue and diuretic. In the report by Dunstan, republished in *The Agricultural Ledger* (1900, No. 12), it is pointed out that the gum absorbs more than twice its own weight of water, and that a 10 per cent. solution yielded a thick mucilage which could not be manipulated. Several firms of brokers were asked to report on the gum. The estimated value was from 10*s.* to 20*s.* per cwt. They did not consider the gum of any commercial importance. It must, therefore, be regarded as mainly of local interest. The export from Dehra Dún amounts to about 2,500 maunds per annum, and the local valuation is about Rs. 1–8 to Rs. 2–8 per maund.

Oils.

Dyes and Tans.

Several species are reported to yield OILS, *e.g.* ***B. acuminata***, ***B. tomentosa***, etc., but information as to their economic use (if any) is wanting. The bark of ***B. purpurea*** is used in DYEING and TANNING and that of ***B. racemosa*** in dyeing. The latter produces at first a dirty red colour, but the dyed article having been worked up in mud for some hours subsequently appears black or nearly black (*Note by Conservator For., E. Circ. Burma*, 1896).

Fibres.

Bauhinia is, however, principally noted for the FIBRES afforded by one or two species. A cordage, strong but not durable in water, is made from the inner bark of ***B. racemosa***. According to Dodge, this being very tough has been employed in India in the construction of certain bridges across the Jumna. The stems are usually cut in July or August. Concerning the strong cordage prepared from the bark of ***B. Vahlii*** a full account is given in the *Dictionary* (*l.c.* 424) and need not be repeated here. It is a very important article with the hill tribes. The *malu* fibre is one of the few that will stand to be dyed, bleached and worked up along with wool (Watt, *Res. of Brit. Ind.*, 1894, 15). In certain districts ropes are made from it in two ways. Either real fibres of the branches are extracted and twisted into ropes or the branches are simply split up and used as natural ropes. They are known in the Panjáb as *udála* and are extensively employed for tying slates and thatch on to roofs (Gee, *Monog. Fibrous Manuf. Pb.*, 1889–90, 5). The shoots are said to grow as much as 50 feet long in one year.

Medicine.

Whilst it may be said that most of the species enumerated above are used in some way in Native MEDICINE, almost every part of ***B. variegata*** is so used. The bark, flowers, and root are triturated in rice-water for use as a cataplasm. A decoction of the root is given in dyspepsia, the flowers are taken with sugar as a laxative, and the bark is regarded as tonic and anthelmintic. The medicinal use of the gum of ***B. retusa*** has already been mentioned. ***B. tomentosa*** is said to be antidysenteric and to be useful in liver-complaints. The leaves of ***B. Vahlii*** are demulcent and the seeds tonic and aphrodisiac.

Food and Fodder.

The acrid leaves of ***B. malabarica*** are used as FOOD in Burma and Bombay, and elsewhere the young shoots are eaten as a vegetable. The flowers of ***B. purpurea*** are used in curries as a pot-herb or are pickled. The leaves form a cattle-FODDER. The buds and seeds of ***B. racemosa*** are eaten by

Timber.

Cigarette-covers.

Natives and the leaves are relished by buffaloes in N. India. The seeds of ***B. Vahlii*** are eaten raw or fried, and the young pods of this species and also of ***B. variegata*** are cooked and eaten by some of the hill tribes. The TIMBER of ***B. purpurea*** is used for agricultural implements, but of the other trees of this genus the wood is mainly useful for burning. The leaves of ***B. variegata*** and ***B. racemosa*** are made into cigarette-covers (*bidis*)—those of the former are said to be exported to Sind and Persia, while the latter in the Thana district alone bring a revenue of Rs. 1,500 a year. Those of ***B. Vahlii*** are made into cups, platters, etc., and the bark of this climber, as of ***B. macrostachya***, is used for matchlocks. Finally, the leaves of ***B. racemosa*** are worshipped at the Dasara festival.

D.E.P., i., 426-33.

BEADS.—These may be referred to three groups :—

(1) Mineral, including glass and stone-beads, alabaster and metal ornaments, etc.

(2) Animal, including bones, corals, pearls, shells, etc.

(3) Vegetable, including flowers, fruits, seeds, etc.

Mineral.

(1) In the MINERAL group there is a large import trade, especially from Italy, in glass beads. The value of the trade in 1902-3 was Rs. 16,51,325, representing 14,437 cwt. of goods, and in 1906-7, 22,520 cwt. or Rs. 24,02,442 (see **Glass**, p. 563). A considerable internal trade is also done in the cheaper kind of stones which are collected on the mountains of India and Burma, as also brought across the northern land frontier (see **Gem Stones**, p. 560). Small beads made of various metals are also common, the more elegant being gold beads mixed with precious stones or coral.

Animal.

(2) Personal ornaments derived from the ANIMAL kingdom are chiefly Cowrie and Conch shells (see **Shells**, p. 989), feathers of birds, skins, furs, horns, bones, the smaller pearls, etc. Such information on these subjects as can be here given will be found under the respective articles, Birds' Skins and Feathers (see under **Birds**, pp. 138-42; **Bones**, p. 169; **Hides**, p. 639; **Horns**, p. 645; and **Pearls**, p. 557).

Vegetable.

(3) In the *Dictionary* (i., 430-3) will be found a complete enumeration of the various plants of which certain parts are used for beads, rosaries, garlands, etc. In the more important instances the domestic uses will be found under the plant-names in their proper alphabetical positions—**Adhatoda, Ægle, Coix**, etc., etc. [*Cf.* Vieux, *Agri. Ledg.*, 1906, No. 6.]

D.E.P., vi., pt. ii., 493. Sea-slugs.

BÊCHE-DE-MER: Sea-slug; Tripang; Suala, Swalloe, or Swallow, etc., names given to various forms or qualities of the Edible *Holothurian*; Thurston, *Mar. Fa. Rameswaram, Mad. Cent. Mus.*, sc. ser., 1887, No. 1, 15, etc.

Supply.

Habitat.—These edible Sea-slugs are found on the coast of the Mediterranean, the Eastern Archipelago, Australia, Mauritius, Ceylon and Zanzibar, whence they are occasionally brought to Bombay for re-export to China. Several species are found on the shores of the Andaman and Laccadive Islands and on the Burmese coast, particularly that of the Mergui Archipelago, where they are collected from the Nicobar Islands, the Maldives, the Gulf of Manár, etc., cured and sent to China *viâ* Burma and Madras ports. It is, however, mainly from New Caledonia, Tahiti and the Fiji Islands that China is supplied.

Preparation.

Preparation.—Very little of a satisfactory nature is known regarding the Indian and Burmese species and qualities; the methods of collection, curing and drying; system of packing and exporting; chief towns concerned in the trade; seasons of collection, prices, etc., of these edible products. In fact very little of a practical nature has been contributed since Capt. Andrew Cheyne wrote his account —an abstract of which will be found in the *Dictionary*. Mr. Thurston tells us that "The Tripangs are collected by Natives, as they lie on the mud at low water, and placed in a cauldron which is heated by a charcoal fire. As the temperature rises in the cauldron, the still living animals commit suicide by ejecting their digestive apparatus, etc., and become reduced to empty membranous sacs, which, by loss of water consequent on the temperature to which they are exposed, shrivel up considerably. At the end of twenty minutes or half an hour the boiling process is stopped, and then the same process is repeated for a similar time. Finally, they are arranged in order according to their size, and are then ready for shipment to China."

Trade.—The tripang is highly esteemed as an article of food by the Chinese and Japanese epicures. Minced down it is made into a thick gelatinous soup. It is seldom used by the Europeans in India, but is reported to be a favourite article of diet with the colonists of Manilla. The trade returns usually record a fairly large traffic to and from India and Burma. The foreign imports of India during 1901–6 averaged about 28,000 lb., valued at Rs.10,000, and these came from Ceylon, the Straits Settlements and Hongkong, and were consigned to Madras and Burma. In 1906–7 the actual imports were 6,744 lb., valued at Rs. 2,796. Formerly, of the exports of Indian Bêche-de-Mer an average of about 100,000 lb., valued at Rs. 24,000 a year, went from Burma and Madras to the Straits Settlements. But within recent years the trade seems to have been declining, the exports in 1903 having been approximately 32,000 lb., valued at Rs. 6,000. Since then, however, they have fluctuated greatly, and in 1906–7 were 44,468 lb., valued at Rs. 14,343. [*Cf.* Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 165; Forrest, *Voy. Mergui*, 1783, 83; Milburn, *Or. Comm.*, 1813, ii., 305; Raffles, *Hist. Java*, 1817, i., 203–8; Royle, *Prod. Isinglass*, 1842, 54; Crawfurd, *Dict. Ind. Isl.* and *Adj. Count.*, 1856, 440; Collingwood, *Rambles of a Nat.*, 1868, 150; Mason, *Burma and Its People*, 393, 728; also (ed. Theobald) i., 20; Hunter, *Imp. Gaz.*, x., 295 (*Expt. from Nicobars*).]

Soup.

Imports and Exports.

BEES: BEES'-WAX, BEES'-DAMMAR AND BEES'-HONEY.—It has to be admitted that in India Bee-culture takes a remarkably subordinate position. Whilst met with occasionally on the hills, it is a completely neglected industry on the plains as a whole. This circumstance is doubtless an expression of the influences, whatever these may have been, that consigned horticultural and dairy operations to village artificers rather than to farmers or agriculturists proper.

The religious sentiment against taking life may doubtless have had a restricting power, and perhaps the climate and the seasons of flowering, together with the nature of tropical vegetation, may have been ascertained to be unfavourable, and thus have acted prejudicially against the establishment of regular bee-culture. But while there is no organised industry, bees exist plentifully here and there all over India and Burma, in a wild or semi-domesticated condition, and supplies of both honey and wax are plentiful and of fair quality. It seems to be generally upheld in India that bee-culture is impossible in regions where species of *Strobilanthes* do not abound.

The following may be given as the chief honey and wax-yielding bees and the products derived from them, together with the references to standard works regarding the same:—

I. BEES; Horne, *Trans. Zool. Soc.*, vii., 181–4; Gale, *Bees, and How to Manage Them, Agri. Gaz. N.-S. Wales*, 1898, ix., 791–5, 1286–8, 1397–1401; also Pender, *Prod. Honey*, 796–802, 899–907; Hooper, *Agri. Ledg.*, 1904, No. 7, 73–80; also *Rept. Labor. Ind. Mus.*, 1903–4, 25–6.

D.E.P., i, 434-7.

(*a*) **Apis dorsata,** *Fabr.*; Bingham, *Fa. Br. Ind.* (*Hymenoptera*), i., 557. The Wild Bee or Rock Bee of India: the *vowra, khago, konegi* or *konge, dangara, sarang, bhammar, mahal, mahuk, bhavra, lywai, aghya, age, togri, tagara, bhagu mohu, pedda-pera, peria-them, perai-tenai-egalu, malai-teni, pya-gyi,* etc.

Rock Bee.

Habitat.—Found throughout India and Burma, but rarely ascending the hills to altitudes above 2,000 feet. It would seem to be most prevalent in localities where species of *Strobilanthes* abound, and is reputed to move from one locality to another with the somewhat spasmodic flowering of the plants on which it seeks for its supply of honey, etc. Bingham remarks, "So far as my observation goes, *Apis dorsata*, *Fabr.*, the largest of the three species, in

Largest Indian Species.

Combs.

its wild state builds its combs exclusively more or less in the open—that is to say, on the undersides of the branches of large trees, in caves or under overhanging rocks, in buildings, etc." The combs are three to five feet long, and two feet or more deep: they consist of cells that are 4½ to the inch. Only occasionally is a second comb built, side by side with the first. Some of these combs weigh as much as a maund, and an average one gives from 10 to 20 lb. of honey and from 2 to 3 lb. of wax. Mr. J. D. Douglas's note in the *Dictionary* (*l.c.* 435) furnished the following reasons against the systematic cultivation of this species:—1. It builds naturally in the open. 2. It makes as a rule but one comb, so that honey cannot be removed without destroying the brood. 3. Its comb though large is not so great in cubic capacity as the combs of the ordinary domestic bee of Europe (*A. mellifera*). 4. It is only met with in tropical countries. It may be added that it is a vicious, intractable insect.

Indian Semi-Domesticated Species.

(*b*) **A. indica,** *Fabr.*; Bingham (*l.c.* 558); the Indian SEMI-DOMESTICATED BEE: the HILL BEE; the TREE BEE of Indian writers, or *sathpuria, satha, sateri, satpada, mohury, mohri, aira, ngap, yung, manchtilr, doar, doyer sadhi, satde, kol, tudir-jen, aduku theni, thorá egalu, pya aung,* etc.

Combs.

Yield.

Habitat.—Found throughout India and Burma and ascending the hills to 9,000 feet. In the high altitudes of its area, such as Bhutan, Hazara, Kashmir, Khasia hills and Simla, the insect seems to become larger than when met with in the plains and lower hills. Unlike *A. dorsata* it does not as a rule live in the open, but chooses hollow trees, overhanging eaves, crevices in walls, etc., and shows a preference for proximity to human dwellings rather than for the hearts of forests or the faces of inaccessible rocks. There are several combs, one above the other, hence the name *sathpuria* or seven-layered. The cells are about 5½ to 6 to the inch. The yield of honey from a fair-sized hive would be from 10 to 40 lb., and of wax from 2 to 10 lb.

Domestication in Temperate Tracts.

Mr. G. Minniken, in a report published in the *Dictionary* (iv., 268), gives an interesting account of the degree of domestication practised on the Himalaya, and that may be here epitomised since it is fairly representative of the bee-culture of India. In Beshahr, he says, houses—one, two or three stories high—are often specially kept for rearing bees. In these, small recesses are made in the walls, two feet apart and closed on the outside by a wooden panel in which an entrance hole is made. A man is usually in charge of each such bee-house, whose duty it is to prevent over-swarming. This is effected by giving each colony ample room, and sometimes by clipping the wings of the queen. He has also to keep the apiary well stocked with early swarms, and to guard it against the rapacity of bears, martens, hornets, caterpillars, etc. Stocking is most generally effected by capturing wild swarms and bringing these to the apiary. But where bee-culture on a large scale is not contemplated, it is customary for the hill people to provide one or two recesses in the walls of the ordinary dwelling-houses in which a few swarms may be reared. In the Simla district it is believed the best honey is procured in localities where *Plectranthus rugosus* (the *pekh*) abounds.

Kashmir Bee.

The Bashahr system is followed in Chamba, Hazara, Jhelum, Kangra and Kullu. Swarms are looked for in the jungles, and carried off to the zamindar's house. In Kashmir, a honey-bee—*manchtilr*—is almost completely domesticated, and seems to be a variety of *A. indica* hardly separable from *A. mellifera*. In the Khasia hills a somewhat similar semi-domestication exists, the swarms being captured in the jungles and kept in small boxes under the eaves of the houses.

Smallest Indian Bee.

(*c*) **A. florea,** *Fabr.*; Bingham (*l.c.* 559). This is the smallest of the three Indian bees, but with *A. indica* is much more closely allied to the European honey-bee (*A. mellifera*) than to the Indian rock bee (*A. dorsata*).

Semi-tropical Species.

Combs.

Habitat.—It has been collected in Bengal, Assam, Burma, Madras, Malabar, Central Provinces, Central India, the United Provinces and on the Himalaya from Kumaon and Sikkim. It might in fact be viewed as a slightly more tropical species which displaces to a large extent the western and northern *A. indica*. It has been called FLOWER BEE by some writers, and appears to be the *kátyál, lamai, tudbi, zinya, kol-jen, kom-buthem, thodi-pera, pullu-egalu* or *pulla-tenai-egalu, yin-pya,* etc., etc. Its combs consist of cells that are nine to the inch. It would appear frequently to build in the open a single comb suspended from branches of trees or rather thorny bushes, especially near river-banks, but sometimes it selects cavities in walls or hollow trees, or builds under the cornices or other protecting parts of houses. It is a comparatively harmless insect, and about the size of the domestic fly. It is probable that the *mohri* or

Khandesh Bee.

morhi bee of Khandesh, found on bushes in the vicinity of large expanses of ***Strobilanthes***, is but one of the many varieties of this species.

Burmese Bee-culture.

The honey it affords is but small in quantity, and when found on trees is thin in quality. It appears to improve when produced within large combs in protected hives. In Burma (Kachin country) a sort of domestication has been attempted apparently with this species, though with little success. According to some writers its honey is superior to that of the other two species. In Burma as a whole, however, ***A. dorsata*** is regarded as the most valuable insect, though it is never domesticated in any way.

[The following additional works may be consulted:—Linschoten, *Voy. E. Ind.*, 1598, i., 21, 67, 130; *Ain-i-Akbari* (Gladwin, transl.), ii., 37, 80, 95; Hoffmeister, *Trav. in Ceylon and Cont. Ind.*, 1848 (Engl. transl.), 339; Adams, *Wand. Nat.*, 1867, 80; Lewin, *Wild Races S.E. Ind.*, 1870, 80; Hooy, *Monog. Trade and Manuf. N. Ind.*, 40; Douglas, *Handbook Bee-keeping Ind.*, 1884; Bingham, *Journ. Bomb. Nat. Hist. Soc.*, 1888, iii., 183; Cunningham, *Plagues and Pleasures of Life in Beng.*, 1907, 34–9, etc.]

D.E.P., iv., 263–71.
Wax.

II. BEES'-WAX.—This substance is best known by the following names—*mom, sinth, mena, min, mozhukin, mainam, mezhuka, lelin, phayoni,* and in the classic—*madhujam, siktha, shama,* etc.

Season of making.

Bleached.

Coloured.

The observations already made regarding the species of bees met with in India afford incidentally certain particulars regarding wax. It may, however, be useful to disregard the individual insects and to bring together provincially the particulars available regarding the centres of supply. The season for making wax would appear to be the hotter months, viz. April to June. The separation of the honey from the wax is usually done in the crudest manner possible by the persons who collect the combs. Refinement is rarely practised, but adulteration is not usual, and although under the Indian sun it might be readily bleached, Indian wax is rarely so treated, but on the contrary is purposely coloured with turmeric. It is made up in balls, rolls, cakes or blocks, sometimes moulded and at times even as much as 2 feet in diameter and 6 to 9 inches in thickness.

Hooper's paper (*l.c.* 82–100) should be consulted for fuller details, but the following abstract may be useful:—

Regions of Supply.
Calcutta.

Bengal.—Supplies are drawn by Calcutta from the Sundribans, Chota Nagpur, Chittagong, Darjeeling, Bhutan and Nepal. It would appear that average qualities realise from Rs. 53 to as much as Rs. 75 a maund. It is largely consigned to Singapore and the Straits Settlements.

Sylhet.

Assam.—The dealers in wax reside in Sylhet, and they derive their supplies from the Khasia hills and wild tracts beyond the frontier. Naga wax is usually sold in rolls cast in bamboo moulds. Assam wax is of inferior quality as a rule.

Saharanpur.

United Provinces.—The right of collecting honey and wax is leased, but a decline in the supply has recently taken place. It is drawn from the Eastern Dun Forests, Khari, etc. The trade is chiefly in the hands of traders resident in Saharanpur. It fetches about 11 annas a pound, the imported foreign bleached wax realising about 9 annas.

Ratgarh.

Seasons.

Central Provinces.—It has been stated that the forests of these provinces are capable of yielding 500 maunds of honey and 100 maunds of wax annually. In Chadgarh bees are so plentiful that it is impossible to beat the forests for big game. Ratgarh hill has been described as a "hive of bees." The following are the chief localities of supply in alphabetical sequence of names—Betul, Chanda, Chhindwara, Damoh, Hoshangábád, Jabbalpur, Mandla, Nimar, Raipur, Sambalpur and Wardha. Wax fetches locally, according to quality and season, from 3 annas to 12 annas per pound. There are said to be two seasons for collecting—April to May, and again November to December.

Supplies of the Hills.

Panjáb.—Bee-culture and the collection of honey and wax from wild bees seems to be confined to the hilly country. The districts most famed are Bashahr, Chamba, Hazara, Jhelum, Kangra, Kashmir, Kullu, Simla, etc. Certain

Rampur.
Seasons.

particulars have already been given of these localities that need not be repeated. The Bashahr supply comes usually to about 20,000 lb. of wax that is sold at the annual fair of Rampur. In Hazara, bee-keeping is practised for the sake of the honey, and the wax obtained appears to be largely used up locally. In Kangra it is said 2 to 3 maunds of the annual productions are employed by the brass and coppersmiths in moulding their wares. In Hazara the honey is collected in November, in Kullu during July and again in October, while in Chamba the seasons are May to June and September to October, and in Kashmir it is gathered from September to October. The hives contain from 20 to 40 lb. of honey and 2 to 4 lb. of wax.

Afghanistan.

Kuram Valley and ***Afghanistan.***—Bees are believed to be extensively kept by the hill people, and the produce is to some extent exported to India.

Rajputana.—Honey and wax are collected at Ammer, Baojari, Dewari, Mandla, and Todgarh, but the supply of wax is very small.

Khandesh.
Prices.

Bombay.—The honey and wax of this Presidency are drawn mainly from Khandesh (Satpúra mountains largely) and the Deccan. The chief localities are Belgaum 1,500 lb.; Dharwar, 1,500 lb.; Kanara, 3,000 lb.; Panch Mahals, 4,000 lb.; Ratnágiri, Satpuras, 500 lb.; Satara, 560 lb.; Salsette, etc. The figures denote the approximate annual supply. Locally it fetches from 4 to 10 annas a seer (2 lb.); the Bombay maund in some returns is 28 lb., and the price of wax per such maunds is quoted at Rs. 14 to 20; in other cases the maund is 40 lb. and the price returned as Rs. 25 to 30. The wax is said to be usually about one quarter the value of the honey. The exports from the Presidency go mainly to the towns of Bombay and Goa.

Berar.—The districts most noted are Ellichpur, Mangrul, Melghat, and Wun. The supply is not large, and the local price is about 4 annas a pound.

Madras.
Prices.

Madras.—Bees are met with on all the mountains and low hills of the Madras Presidency, but the following are the chief centres of supply in alphabetical sequence of their names:—Bellary, 800 lb.; Coimbatore, 8,000 lb.; Cuddapah, 3,500 lb.; Ganjam, 1,600 lb.; Godavari, Kistna, Karnul, 6,000 lb.; Madura, Malabar, 200 lb.; Nellore, 500 lb.; Nilgiri, North Arcot, South Kanara, Trichinopoly, and Vizagapatam, 700 lb. The figures give the annual supply of each of the places named. The Madras maund is 25 lb. and wax is said to sell at from Rs. 10 to Rs. 20 a maund, but it is often to be had at 4 annas (say Rs. 5 a maund) or it may fetch as much as 12 annas a pound.

Burma.
Upper Chindwin.

Burma.—Following the system pursued with the provinces of India, the following may be mentioned as the centres of Burmese supply:—Bhamo, Chindwin, Katha, Mandalay, Minbu, Pyinmána, and Tenasserim. In the Upper Chindwin there seems to be a prosperous trade in honey and wax. It is brought for sale in the Kabaw valley. In the lower Chindwin, Mankadaw is the mart. It is probable that the total supply from the Chindwin comes to something like 4,000 to 6,000 viss (viss = 3·65 lb.). The rate at which it is sold comes to about 10 annas a pound, but in the towns a much higher figure is quoted. In Tenasserim it averages from 9 annas to Rs. 1-5 a pound. It is impossible to give even an approximate estimate of the Burmese total production, but wax is largely imported, so that there cannot be a margin for export.

Low Acid Value.
Uniformity.
No Adulteration.

Chemical Investigations.—Hooper, concluding his report on the extensive series of samples that had been placed in his hands for chemical examination, says: "In studying the tables of analyses" —drawn up as the result of the investigations conducted in the Indian Museum—" two very interesting facts will be revealed. The first is the lower acid value of Indian bees'-wax; this indicates a different ratio between the cerotic acid and myricitin compared with that of waxes from other parts of the world, and the second is the uniformity in composition of the secretion of the three kinds of Indian bees representing the APIS family. The appearance of the wax from the three species gives no clue to the origin, and although there are two or three somewhat abnormal deviations from the average on account of the high saponification value and the wide range of the iodine value, there is very little, if any, suspicion of adulteration. The wax from the combs of *Apis dorsata*, *A. indica*, and *A. florea* is, therefore, practically identical in composition, and a combination of the wax of one species with that of another cannot be regarded as a fraudulent admixture. It must be admitted, however, that the ***Apis dorsata,*** because of the much larger comb it manufactures, is the chief source of the bees'-wax of the country." "It is satisfactory to record that out of 64 samples collected from different parts of India only 3 were really adulterated, or less than 5 per cent. of the total, and there is no evidence that the sophisticated wax was a native product or was manufactured in the country."

Uses. Candles. Moulding. Calico-printing. Medicine.

Uses of Wax.—It is perhaps hardly necessary to mention the uses of wax. The introduction of paraffin and other composition candles has removed, to a large extent, the demand for wax to be used as votive offerings at the temples and churches. Jahangír (*Memoirs* (Price, transl.), 3) alludes to camphorated wax lights used in the palace. It is, however, required by the silver and goldsmiths, also by brass and copper foundrymen, to give finishing touches to their moulds and to be subsequently liquefied and dispelled by the molten metal poured into the matrix. There is a considerable demand in Burma for it, accordingly, in the workshops that turn out the brass idols of Buddha. Wax is also fairly extensively employed as a resist in certain stages and methods of calico-printing (*Ind. Art at Delhi,* 1903, 229–30, 259–67). Lastly, it is largely used by the shoemakers of India. In MEDICINE wax is extensively employed in the preparation of ointments and plasters.

"Propolisine."

Recently some interest has been observed in a substance called "*propolisine,*" derived from the propolis of bees (see below) by dry distillation. It is said to destroy all known bacteria without danger to human beings.

Total Trade.
Exports.

Wax Trade of India and Burma.—During the past twenty years the exports of wax have practically remained stationary. The highest figures occur in 1905–6—viz. 8,593 cwt., valued at Rs. 7,31,320, and in 1894–5, namely 7,487 cwt., valued at Rs. 7,05,247 the lowest in 1896–7—viz. 3,142 cwt., valued at Rs. 2,76,190. In 1906–7 they were 8,162 cwt., Rs. 5,96,009. The major portion of these exports go from Bengal, and the chief receiving countries in 1905–6 were Germany, 2,854; the United Kingdom, 2,609; Belgium, 988; Straits Settlements, 622; United States, 408; France, 406; all other countries making up the balance of 8,593 cwt., the exports for the year. [*Cf.* Milburn, *Or. Comm.*, ii., 315.]

D.E.P., iii., 17; and vi., pt. i., 320-2.
Bees'-Dammar.
Propolis.

III. BEES'-DAMMAR.—Bingham, *Fa. Br. Ind.* (*Hymenoptera*), i., 559–64; Cooke, *Gums, Resins, etc.*, 1874, 95–7; Hooper, *Agri. Ledg.*, 1904, No. 7, 79 *et seq.* The DAMMAR BEES, as the little insects that afford this substance are called, belong to the genus ***Melipona,*** or, as it has been called, ***Trigona.*** A resinous substance employed by several species of this genus in forming their nests, is an article of commerce. It has been said to be chemically allied to *propolis,* the substance used by the domestic bees to repair injuries to their hives or to stop up useless and objectionable openings. These very minute and stingless bees are met with all over India and Burma. Among the collections recently brought together some 40 samples of wax, honey, etc., were identified, through the insects that accompanied them, as being the product of species of ***Melipona.*** These came from the following localities, the figures denoting the number of separate samples to hand : Almora (2), Basin, Belgaum (2), Betul (3), Chhindwara, Coimbatore (4), Damoh, Dehra Dun (4), Dharwar (2), Kanara (2), Khandesh (3), Madura, Nellore, Nilgiris (2), Panch Mahals, Raipur (2), Ratnagiri (3), Rawalpindi, Sambalpur, Singbhum, South Kanara (2), Tenasserim and Tinnevelly (2). It will thus be seen that these insects are practically distributed all over India and Burma, and perhaps to a greater extent than was known to Bingham when he wrote his *Hymenoptera.* That distinguished author describes twelve species, of which ***Melipona læviceps*** of Tenasserim is the most interesting, since it affords (or at all events, is the

Pwé-nyet.

chief source of) the resinous substance known as *Pwé-nyet.* The following are the vernacular names for the specimens of ***Melipona*** recently procurèd :—*kunti, kote, kuntali, poye, nasari, bhinkwa, bankua, misri, nasrijen, kosutteni, kulliada, musuruteniga, moye byah,* etc., etc.

PWÉ-NYET.—The insects referred to are said to build nests in hollows within trees, crevices among rocks, and sometimes in holes in stone walls, etc. The interior surfaces of the nests are lined with a resinous substance, and the entrance is often formed into a beautiful projecting funnel also composed of a resinous substance—the product for which these insects are valued. When the nests are small, the resinous substance (or bees'-dammar) is not collected, but in the case of ***M. læviceps*** " the trumpet-shaped structure of resinous wax which very often forms the entrance to the nests " projects from the hole in the tree for a foot or more. " Horne gives an interesting account of the finding of the nest of ***M. ruficornis,*** and states that the hollow in which it was built was coated all over with a layer

Honey.

of black wax, and that the cells, containing a dark honey of excellent flavour, were globular in shape, pendent side by side from the roof." ***M. ruficornis*** is apparently the only Indian species that has been systematically described. Whether the forty odd samples indicated above are one and all derived from this or from several species has not as yet been ascertained. Horne's description of the resinous lining and the comb is most valuable. Mr. Parish is careful to advise us that he had not seen the interior of a hive of the *pwé-nyet,* but he suggests

Suggestion as to Formation.

that the external trumpet-shaped structure may be constructed by the bees from the resin of ***Hopea odorata*** and other trees mixed with the oil of ***Dipterocarpus lævis.*** Hooper (*Rept. Labor. Ind. Mus.,* 1904–5, 23–4) furnishes a report on two samples examined by him. It is, he says, a peculiar compound of various resins and gum-resins. In a fresh state it may be moulded to any shape. Its constants were determined as well as its solubility in alcohol and ether. He promises a full report in the future, but for the purpose of comparison has specially studied the resins and oleo-resins of ***Hopea, Vateria, Canarium,*** and ***Dipterocarpus.***

Composition.

So far, therefore, Hooper seems to confirm the popular opinion that *pwé-nyet* is composed of certain gums and resins collected by the insects from trees. Speaking apparently of the wax of the combs, Hooper further observes : " The wax of the species of ***Melipona*** has quite a different character and composition compared with that of the true bees. The blackish colour, sticky consistence and higher melting point, acid and iodine values readily distinguish it." According to Greshoff and Sach (*Pharm. Weekblad.,* 47, 933), the substance consisted of a mixture of 84 parts resin, 12 parts wax with 4 parts of an impurity insoluble in alcohol. The resin melted at 60° and the wax at 66°. But it is not quite certain whether they had examined the true wax or the *pwé-nyet.*

Uses of Pwé-nyet.—" The resinous product collected and used by the bees in making their nests is called '*pwé-nyet*' by the Burmese, and after boiling in water and mixing with earth-oil or petroleum, it is largely used for the

Caulking Boats.

caulking of boats. The right of collecting '*pwé-nyet*' is sold by the Local Government in Burma and Tenasserim yearly, and forms one of the sources of revenue under Minor Forest Products" (Bingham, *l.c.* 560).

D.E.P.,
iv., 263 71.
Honey.

IV. BEES'-HONEY.—The best names for honey are *shahad, madh, madhu, sahut, saht, polée, tén, jenu, piya-ye,* etc. The honey-bee would be *shahd-ki-makhi.*

Production.

It is not necessary to deal with this subject in detail after the treatment already given to Bees and Wax. The regions of production of the latter are

Preservative.

Intoxication.

A. dorsata Honey.

Kundah.

necessarily those of the former. Occasionally, however, the wax is neglected and the production and sale of the honey becomes the important aspect. Honey is a plentiful wild product over the greater part of India, and is obtained also from bees in a state of semi-domestication, chiefly in the hills of the Panjáb. It is highly appreciated as an article of food by the inhabitants of many parts of India. It is also employed to preserve fruits, and in the Khasia hills, apparently, human bodies are sometimes temporarily preserved in it. At certain seasons, due doubtless to the flowers visited by the bees, or possibly to the species of insect, the honey has intoxicating and even poisonous properties. The honey of the various species of Indian bees, mentioned above, at all events varies considerably. The most abundant is that of ***A. dorsata***, which provides the greater portion of the honeys of the United Provinces, the Central Provinces, Berár, Bombay, Madras and Burma. This is the insect of the Kundahs, the honey of which is collected in March and again in September. The March crop is the best. Mr. A. Mervyn Smith published in the *Statesman* in 1895 a most instructive account of the Honey and Wax collection of the Kundah country. As this is representative of the operations pursued in the Nilgiri hills, in the Wynaad, in the Sattyamangalam hills and elsewhere, a fairly extensive passage may be abstracted :--

Method of Collection.

Cane-ropes.

Wood-smoke.

"A strong stake was driven into the ground 15 or 20 feet away from the edge of the precipice, as a purchase for the rope, as it was being lowered down the face of the precipice. One end of the cane-rope had a double loop, in which a Kooramber seated himself, his feet being supported by a short stirrup of bark. A light, reed-like bamboo, 20 feet long, armed with a reaping-hook at the end, served to cut the combs from the rocks. A small landing-net below the sickle received the combs as cut. A light cord, running through a loop about 10 feet above the head of the gatherer, and fastened to the sickle-end of the rod, enables the gatherer to use the rod as a derrick, which he can raise, lower, and swing to any position, without being inconvenienced with the weight of the combs in the net. When the net is full, he empties the contents into a large close-framed basket lined with leaves, which is suspended from a separate cord ; and this basket is drawn up when filled. The occupation of gatherer is extremely dangerous and requires steady nerves. In many cases the men are suspended 400 feet from the top of the cliff, with many hundreds of feet below them to the bottom of the precipice. These cane-ropes are immensely strong and stand more rough usage than one made of fibre, and they are also extremely light. The suspending rope is shifted about from place to place in answer to signals with the hand from below. Immediately the bees are disturbed, they crowd round the gatherers in myriads. The men are literally covered with a coating of bees from head to foot and present a most curious appearance, just as if they were covered with rusty chain armour, each link of which is in motion. The pungent smell of the wood-smoke from the bodies of the gatherers has a kind of paralysing effect on bees and prevents them stinging. The flight of bees thus disturbed could be distinctly seen from where we were, half a mile off, and resembled a flight of locusts. We could even hear the humming noise made by the irritated insects. In about two hours all the combs within reach had been collected and the ropes were drawn up."

A. indica Honey.

The Hills.

Medicinal Properties.

The next most important honey is that of ***A. indica***, an insect found here and there all over India, but semi-domesticated in the Khasia hills and the mountains of the United Provinces, of the Panjáb and of N.W. Frontier Provinces. It is accordingly the chief source of the honeys of Assam and the Panjáb, and possibly also of Bengal. The third form is hardly a commercial article, though when found in sheltered positions it is said to be remarkably good It is the honey of ***A. florea***. This is met with in the Central Provinces, Bombay, Berár, Madras and Burma. Lastly, some of the species of ***Melipona*** afford honey. This is incidentally alluded to by Hooper all through his review of the information recently collected by the Reporter on Economic Products. He tells us that it is often tainted with a peculiar odour, and has a bitterish and acid taste. It has, however, a considerable reputation in many parts of India for its medicinal properties. In some parts of the country (Nellore) the honey of the dammar-bee is said to be intoxicating, and in Kanara it is reported that the insect is semi-domesticated. [*Cf. Institutes of Manu*, iii., 119 ; v., 41 ; viii., 131, etc. ; Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 167; Lawrence, *Valley of Kashmir*, 1895, 366 ; *Journ. Board Agri.*, 1898, 335–9 ; *Bee-keeping, Imp. Dept. Agri., West Ind.*, 1901.]

D.E.P., i., 439-41.

BENINCASA CERIFERA, *Savi.; Fl. Br. Ind.*, ii., 616; Cucurbitaceæ. The White Gourd Melon, *péthá*, *kumhra*, etc., an extensive climber cultivated in India; native of Japan and Java.

Sown at the beginning of the rains or in the hot weather, it continues fruiting until the close of the rainy season. The fruit excretes a waxy bloom which it is said can be made into candles. The seeds yield a mild, pale Oil. The fruit possesses alterative and styptic properties, and is popularly known as a valuable antimercurial. It is also used as a vegetable and in curries or is made into a kind of candied fruit called *heshmi* or *heshim*, sold at about 3 lb. to the rupee.

Oil.
Medicine.

D.E.P., i., 442-7.
Barberr

BERBERIS, *Linn.: Fl. Br. Ind.*, i., 108-2; Gamble, *Man. Ind. Timbs.*, 28-30; *Pharmacog. Ind.*, i., 64-8; Duthie, *Fl. Upper Gang. Plain*, i., 31-2; Hooper, *Rusot*, in *Journ. As. Soc.*, lxxiii., pt. ii., 176; Brandis, *Ind. Trees*, 28-30; Berberideæ.

There are twelve species of Barberry mentioned in the *Flora of British India*. They are not easily distinguishable, and the vernacular names are therefore probably indiscriminate. The products are common to five or six Himalayan species and may be dealt with collectively. The chief are the following:—

B. aristata, *DC.; chitra, súmlú, kasmal, tsema.*

B. asiatica, *Roxb.; kilmora, maté-kissi, chitra*, etc.

B. Lycium, *Royle; kashmal, chotra, ambar-báris*, etc.

B. vulgaris, *Linn.; kashmal, bedana, ambarbáris*, etc.

Habitat.—The entire Himalayan districts between 6,000 and 10,000 feet, also the Nilgiris, Ceylon, etc., etc. The bushes often constitute thickets many miles in extent.

Dye and Ta
Birch Bark.
Oil.
Medicine.
Rusot.

A Dye is obtained from the roots and stems, which is sometimes used in tanning and colouring leather. It would seem that the colour exists chiefly in the bark and in the young wood immediately below the bark. In the older wood there is less though better quality of dye. Barberry is perhaps one of the best yellow dyes in India, and the supply is inexhaustible. The seeds yield an Oil. The principal use of the barberry is, however, in Medicine, the parts employed being the stem, *dárhalad*, the fruit, *zarishk* or *zirishk*, and the root-bark. A watery extract is prepared from the stem and root, called *rusot* or *rasout* (*Taleef Shereef* (Playfair, transl.), 1833, 87). It is worthy of notice that this extract has the same beneficial effects in the treatment of ophthalmia which have been ascribed by certain Greek and other early writers to *mamiras*. The plants now known in India as *mámírán* seem, however, to be **Coptis Teeta**, *Wall.*, **Corydalis Govaniana**, *Wall.*, and **Geranium Wallichianum**, *Sweet*. The juices of these are still used as applications to the eye, and two of them, at least, contain berberine. In later times the barberry appears to have been extensively sought by European oculists, and it seems to have been the origin of the *Lycium*, whereof the empty pots were found in Herculaneum and Pompeii. [*Cf.* Fluckiger and Hanbury, *Pharmacog.*, 33-5.] *Berberis*-sticks, 1 inch thick and 12 to 18 inches long, are fairly extensively exported from Kangra and thence carried all over India (see **Coptis**, p. 405).

Mámírán.
Lycium.

Trade.—Various preparations of the barberry are used in fevers, the advantage claimed over quinine being that repeated doses of berberine do not cause depression and deafness. The fruit is given as a cooling laxative to children, and the stems are said to be diaphoretic and laxative in rheumatism. The berries are dried like "currants," and thus brought down to the plains. The Trade value of *dárhalad* is stated by Dymock (*Mat. Med. W. Ind.*, 28) to be Rs. 3½ per maund of 37½ lb.; of *rusot*, Rs. 8 to 9; of *zirishk*, Rs. ¼ per lb. Moodeen Sheriff (*l.c.* 15), however, quotes the wholesale price of *rusot* as Rs. 35 per maund, and the retail price as Rs. 2¼ per lb. He says that the fruit (*zirishk*) may be had at Rs. 6 per maund (wholesale), or 6 annas per lb. (retail). Kanny Lall Dey gives the price of the extract (*rusot*) as 8 annas per lb.

Prices.

[*Cf. Paulus Ægineta* (Adams, transl.), iii., 239; Birdwood and Foster, *E.I.C. First Letterbook*, 201, 480; Clusius, *Arom. Hist.*, in *Hist. Exot. Pl.*, 1605, 163-4; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 13-5; Lawrence, *Valley of Kashmir*, 1895, 74-6; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 46-7; *Rept. Cent. Indig. Drugs Comm.*, i., 13; *Journ. Linn. Soc.*, 1891, xxviii., 311-2: *Pharm. Journ.*, 1901, 321, 402-3, 262; Bhaduri, *Rept. Labor. Ind. Mus.*, 1902-3, 28-9; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 250; etc., etc.]

BIRCH BARK

D.E.P., i., 451. Birch.

BETULA UTILIS, *Don.* : *Fl. Br. Ind.*, v., 599 ; Gamble, *Man. Ind. Timbs.*, 668 ; *Pharmacog. Ind.*, iii., 359 ; CUPULIFERÆ. The Indian Paper Birch, *bhújpattra* or *bhuj-patar*, *búrj*, *shák*, *takpa*, *phuspat*, *bhúrjapatra*, etc., etc. A moderate-sized deciduous tree forming the upper edge of arborescent vegetation in the Himalaya (14,000 feet).

Paper.

By some of the hill tribes the bark is regarded as more durable than paper, and it is well known as the material upon which the ancient Sanskrit MSS. of Northern India were written. It is widely used for writing medicinal charms and is said to be found in every druggist's shop. Its uses are, however, varied ; for wrapping up parcels, for surrounding hookah-stems, for umbrellas, for water-tight roof-lining, and apparently sometimes also for clothing. Minute strips are used in certain forms of tie-dyeing. [*Cf. Ind. Art at Delhi*, 1903, 256.] The younger branches are plaited into twig bridges. It has also certain aromatic and antiseptic properties. The leaves are lopped for cattle-FODDER, and the timber is extensively used in the inner arid Himalaya for building, since it is elastic, seasons well and does not warp. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 48 ; Lawrence, *Valley of Kashmir*, 1895, 68–9, 79 ; *Journ. Soc. Chem. Indust.*, 1900, xix., 1141.]

Fodder.

Another species, **B. alnoides**, *Ham.* : *púya udish*, *shául*, *shakshin*, etc., of the outer Himalaya, the Khasia hills and Burma, has a bark which constitutes an important article of FOOD with the Lahúpas in the mountain-tracks of N.E. Manipur In the upper tracts of Kullu, where earthenware vessels are procurable with difficulty, the outer bark is peeled off in long strips and bound around water-pots as a protection. The TIMBER is valued in Nepal for strength and durability.

Food.

Timber.

Bezoar.

BEZOAR.—This is the *padzahr* or *pazahr* of the early Persian writers, a name which usually denotes an antidote or alexipharmic. The word comes into English through the Arabs, who wrote it *bazahr*. The true *bezoar* is a stone or concretion found within the bodies of certain animals, more especially the Persian Wild Goat (*Capra ægagrus*) (Blanford, *Fa. Br. Ind.* (*Mammalia*), 503) (see p. 743).

Sources.—Moodeen Sherif (*Ind. Pharm.*, suppl., 68–70) says there are many kinds or qualities, according to the animal from which procured, such as Goat-, camel-, fish-, snake-*bezoar*, etc. The last mentioned is generally called SNAKE-STONE. But there is no foundation for the very general belief that snake-stone is procured from the head of the snake (see p. 141). Some writers classify the *bezoars* into animal and mineral, the last being a fossil form and possibly often a coprolite. So also numerous references are made by writers on this subject to false or artificially prepared *bezoars*, fabricated apparently from calcined bone. Certain towns are famed for their bezoars, such as Diu and Golconda.

Snake-stone.

Indian Bezoars.

Chemical Examination.—Dr. Davy was apparently the earliest author to examine these stones chemically, and his description of them has been drawn upon by the majority of subsequent writers. Taylor formed nine groups, three being phosphates (of lime, magnesium, or of ammonium and magnesium), one oxalate of lime, and the five others mostly mechanical or obstructive accumulations such as hair, vegetable-fibre, ambergris, etc. Milburn observes that the genuine Oriental *bezoar* is commonly of an oval form and between the size of a hazel nut and a walnut; the larger it is, the more valuable. It is externally smooth and glossy, and is composed of several layers. The colour most prized is a shining olive green. It has a peculiar smell but no taste. Can be scratched easily by a penknife, and when applied to the tongue or any moist surface adheres firmly and absorbs the moisture. The supposed virtue as alexipharmics depends upon this power of absorption, but in Europe it has been proved that they have no special chemical or mechanical merit in support of their varied reputation. [*Cf* Watts, *Dict. Chem.*, 1883, i., 584.]

Milburn's Description.

Power of Absorption.

BIRDS ; Blanford and Oates, *Fa. Br. Ind.* (4 vols. on Birds) ; Jerdon, *Birds Ind.*, 1862–4 ; Henderson and Hume, *Lahore to Yarkand*, 1873, 170–304 ; Hume, *Scrap Book*; also *Nests and Eggs* ; Oates, *Birds of Burmah* ; Barnes, *Birds of Bombay*.

From the standpoint of utility the study of the birds of India might be referred to several sections, of which the following, taken up in alphabetical sequence, may serve to exemplify the chief facts and products of value :—

1. **Birds associated with Agricultural and Horticultural operations,** either beneficially or injuriously. W. L. Sclater (*Ind. Mus. Notes*, ii., 119) gives the following as the chief insectivorous] or helpful birds :—

Accentorinæ, the Hedge Sparrows ; ***Brachypteryginæ***, Ground Babblers ; ***Caprimulgidæ***, Goatsuckers ; ***Certhiidæ***, Creepers ; ***Coraciidæ***, Rollers ; ***Crateropodinæ***, Babbling Thrushes ; ***Cuculidæ***, Cuckoos ; ***Cypselidæ***, Swifts ; ***Dicruridæ***, Drongos or King Crows ; ***Hirundinidæ***, Swallows ; ***Laniidæ***, Shrikes and Minivets ; ***Liotrichinæ***, Ioras and Green Bulbuls ; ***Meropidæ***, Bee-eaters ; ***Motacillidæ***, Wagtails and Pipits ; ***Muscicapidæ***, Fly-catchers ; ***Paradoxornithinæ***, Crowtits ; ***Picidæ***, Woodpeckers ; ***Pittidæ***, Ground Thrushes ; ***Ruticillinæ***, Red-starts and Robins ; ***Saxicolinæ***, Chats ; ***Sylviidæ***, Warblers ; ***Timeliinæ***, Solitary Babblers ; ***Trogonidæ***, Trogons ; and ***Upupidæ***, the Hoopoes.

In addition to these the following partake of a mixed diet, and are partly insectivorous and partly fruit and grain feeders :—***Alaudidæ***, Larks ; ***Brachypodinæ***, Bulbuls ; ***Dicæidæ***, Flowerpickers ; ***Fringillidæ***, Finches ; ***Gruidæ***, Cranes ; ***Limicolæ***, Waders of all sorts ; ***Nectariniidæ***, Sun-birds ; ***Oriolidæ***, Orioles ; ***Otididæ***, Bustards ; ***Parinæ***, Tits ; ***Phasianidæ***, Pheasants ; ***Rallidæ***, Rails ; ***Sibiinæ*** Sibias, White-eyes, etc. ; ***Sittidæ***, Nuthatches ; ***Sturnidæ***, Starlings and Mynas ; ***Tetraonidæ***, Partridges ; ***Turdidæ***, Thrushes ; and ***Turnicidæ***, Button Quails.

Protective Legislation.

It is highly important that the majority of the above-enumerated families of birds should be protected against ruthless destruction. The conditions and necessities of India are, however, so very different from those of Europe that legislation, easy of application in the latter, often becomes next to impossible in the former, where the customs of the people, their complex vested interests, their immense numbers and the vastness of the territory they occupy, are facts of supreme moment in the enforcement of even urgently needed legislation. To Surgeon-General George Bidie, C.I.E., is due much of the credit for bringing about the existing Indian legislation for the protection of birds. In 1887, however, the Government of India brought into force a law for the " Protection of Wild Birds and Game " (Act xx. of 1887) : this allowed Local Governments to define Wild Birds and to fix the required close season within which it became illegal to possess or sell certain birds. But as its operations were more or less restricted to Cantonment and Municipal limits it exercised little repression on the most objectionable aspects of the traffic, namely, the slaughter of plumage birds in the rural tracts. Accordingly first the Madras, then the Bombay and finally the Panjáb Government sought permission to extend the provisions of that Act. Philanthropic institutions and individuals also continued to press on the attention of the Government of India the desirability of amending the Act. After a full consideration of all the circumstances and evidence His Excellency Lord Curzon in Council issued a Notification (Sept. 19, 1902) which prohibited the taking by sea or by land out of British India skins and feathers of all birds other than domestic except (*a*) feathers of ostriches and (*b*) skins and feathers exported as *bona fide* specimens illustrative of natural history. Thus an effectual check has been given to the reprehensible and destructive traffic, for since no foreign market is now open to the fowler, the trade is practically destroyed. [*Cf. Journ. Bomb. Nat. Hist. Soc.*, iv., 124.]

Legal Definition of Wild Birds.

Prohibitio Exports.

But fortunately few of the purely insectivorous birds are either attractive in plumage or in demand as edible birds. The exceptions are all the more regrettable, viz. (*a*) The Blue Jay or Indian Roller, ***Coracias indica***, the *nilkant*, *sabzak*, *tás*, *pálú pitta*, *kattu kadei*, etc.—one of the most abundant and typical of Indian birds. It is sacred to Siva and a constant associate of the homestead and village lands. Its brilliantly coloured blue plumage led to its wholesale destruction, many thousands of skins being annually sent to Europe. (*b*) The Purple Sun-bird or Honey-sucker, the *shakar khora*, *jugi jugi*, *than kudi*, etc. ; recently a deplorable trade had been organised in exporting the skins of this beautiful and most useful bird. Happily the roller and the sun-bird will no longer be trapped and snared, for the loss of the foreign market practically means the discontinuance of the demand.

The Sun bird.

Injurious Birds.

With regard to the second group it is probable that some of them do more harm than good to the crops amongst which they are to be found. Their protection is not, therefore, so necessary, and those of them that are utilised economically or industrially will be dealt with in further paragraphs.

Cage Birds.

2. **Birds often Reared in Cages, etc.**—F. Finn (*Cage-Birds of Calcutta*, in *Journ. Bomb. Nat. Hist. Soc.* (reprinted from *The Ibis*), xiv., 564–78) furnishes full particulars on this subject, and to that valuable paper the reader is accordingly referred.

The following alphabetical enumeration gives the names of the birds most frequently seen in confinement in India, as also the reference (within brackets) to Blanford, where a full account of each species will be found:—

Acanthis fringillirostris, the Indian Linnet (ii., 228).

Myna.

Acridotheres tristis, the Common Myna (i., 537). Baber, Emperor of India (*Memoirs*, 1519-25, 319), and Abul Fazl in the *Ain-i-Akbari* (Jarrett, transl., iii., 121) call this the *shárak*, and the latter characterises it as an astonishing talker. [*Cf.* E. H. A., *Times of India*, March 25, 1899.]

Caccabis chucar, the *chukor* or Himalayan Partridge (iv., 131).

Carpodacus erythrinus, the Indian or Rose Finch (ii., 219).

Coturnix communis, the Rain or Grey Quail (iv., 114).

Chloropsis aurifrons, the *harriba* or Gold-fronted Green Bulbul (i., 234).

Cittocincla macrura, the *shama* (ii., 118).

Dendrocitta rufa, the Indian Tree-pie (i., 30).

Bhimraj.

Dissemurus paradiseus, the *bhimraj* or Larger Racket-tailed Drongo (i., 325).

Dryonastes chinensis, the Black-throated Laughing-thrush (i., 74).

Koel.

Eudynamis honorata, the Indian Koel (iii., 228). The *Ain-i-Akbari* (*l.c.* 121) observes, "Romance sings of its loves as of those of the bulbul." The Emperor Baber (*l.c.* 323) describes it as the nightingale of India.

Nepal Myna.

Eulabes intermedia, the Nepal or Talking Myna, The Indian Grackle (i., 511). This seems to be the *pindáweli* or *meina* in Baber's *Memoirs*, and which in the *Ain-i-Akbari* is said to imitate the human voice and to speak with great distinctness. [*Cf.* Thevenot, *Travels in Levant, Indostan, etc.*, 1687, iii., 68.]

Francolinus pondicerianus, the *titar* or Grey Partridge (iv., 139).

Galerita cristata, the *chendul* or Crested Lark (ii., 337).

Garrulax leucolophus, the White-crested Laughing-thrush (i., 77).

Hierococcyx varius, the Brain-fever Bird, The Common Hawk-cuckoo or *kupak* (iii., 213).

Melanocorypha bimaculata, the Calandra Lark (ii., 323).

Bulbul.

Molpastes bengalensis, the Red-vented Bulbul (i., 271). [*Cf.* E. H. A., *l.c.*, Dec. 7, 1898.]

Palæornis cyanocephalus, the Blossom-headed Paroquet (iii., 251).

P. nepalensis, the Large Indian Paroquet, *chandana* (iii., 248).

Paroquet.

P. torquatus, the Rose-ring Paroquet, *tota* (iii., 250). Baber (*l.c.*) alludes to this bird.

Pomatorhinus schisticeps, the Scimitar Babbler (i., 116).

Turtle-dove.

Turtur communis, the Turtle-dove (iv., 42).

T. risorius, the Indian Ring-dove (iv., 46).

Canaries.

Introduction of the Cockatoos.

Collection of Live Insects.

Dried Insects.

Of the imported birds a long list might be given, but it is only necessary to say that a fairly large trade exists in canaries brought from the Straits and China: the Java Sparrow (**Munia oryzivora**) has become acclimatised and the Malayan Lorikeet is extremely popular. It would appear that Cockatoos were imported into India as long ago as in the time of Jahangir, for Mr. Finn tells us he has seen a picture of that period depicting a yellow-crested species. The same observer points to the significant fact that there is a larger percentage of insectivorous and frugivorous birds reared by Indian bird-fanciers than in Europe, a circumstance that has led to the creation, as a village craft, of the practice of collecting and selling live insects, white-ants, etc., for these birds. Some years ago it was suggested that one solution of the periodic plague of locusts that here and there annually invades India would be to collect, dry and export these insects as food for the cage-birds of Europe. No one would seem, however, to have acted on that suggestion. [*Cf. Agri. Ledg.*, 1893, No. 2.]

Falcons.

Falcons, Falconry and Hawking.—The bird that was formerly (and to some extent is still) most prized for hawking is ***Falco peregrinator***, the *sháhin* Falcon, the male of which is called *kohila* and the female *kohi.* In the South of India it is known as *jawolum* and *wallur*. To a less extent ***Falco peregrinus***, or *bhyri*, *dega* or British Falcon is also valued. A few other species are occasionally seen trained to strike, such as ***F. Jugger***, the Laggar Falcon, and ***F. cherrug***, the Saker Falcon.

Indian Methods of Hunting.

Nikitin (a Russian who travelled in India from 1468–74) mentions the fact that the Grand Duke Iwan III. sent a present of falcons to the Shah of Shirvan. The *Ain-i-Akbari* (Blochmann, transl., 293–4) gives many particulars of interest. In fact a very extensive series of authors might be quoted in support of the antiquity in India both of the training of and hunting with hawks. Jerdon gives a most interesting account of the Indian methods. As this is reproduced in Blanford's *Fauna of British India* (iii., 416–7) it can be consulted by those interested. Montgomery Martin (*Hist. Topog. and Stat. E. Ind.*, ii., 148; iii., 189, 579) speaks of the falconer as the *mirshekari*. In the *Kangra Gazetteer* (1897, 99) we read of Hindu traders called *paprálas*, who come from Amballa and Patiala to purchase hawks, which they teach and then sell at a profit in the plains. The *Madras Mail* (July 5, 1898) gives many details (derived chiefly from Oates) regarding the catching and rearing of hawks in South India. [*Cf.* Thevenot, *Travels in Levant, Indostan, etc.*, 1687, iii., 38; *Taleef Shereef* (Playfair, transl.), 1833, 140.]

Professional Trainers.

Edible Birds.

3. **Birds, Edible.**—This is necessarily a very large and important aspect of the study of Indian economic birds. It is readily referable to two sections, viz. *domesticated* and *wild*. The former embraces the varied assortment of birds usually classed as "poultry" and the latter corresponds to the "lesser game." In the *Dictionary* the edible birds have been discussed under the following groups :—

D.E.P., iii., 196 7.

(*a*) ***Ducks, Teal, Geese and Swans.***—This corresponds to the ***Anseres*** or ***Natatores***. Blanford, *l.c.* iv., 411–71 ; E. C. Stuart-Baker, *Journ. Bomb. Nat. Hist. Soc.*, xi. to xv. The domestic duck and goose are the most important birds of this assemblage, but the common wild teal, ***Nettium crecca*** (Blanford, *l.c.* iv., 443) is universally eaten, and sometimes reared (or fed up) in a state of semi-domesticity. In Madras Presidency immense flocks of domestic ducks are herded on the flooded fields, their eggs being an important article of export to Burma. [*Cf.* Ainslie, *Mat. Ind.*, 1826, i., 441 ; Campbell, *A Successful Duck Farm*, in *Agri. Gaz. N.-S. Wales*, 1898, ix., 1377–82 : Monier-Williams, *Buddhism*, 525.]

Game Birds.

(*b*) ***Game Birds;*** Hume and Marshal, *Game-Birds of Ind.* ; W. L. Sclater, *l.c.* ii., 117–21. This includes examples drawn from many families such as the Bustards, Cranes, Ducks, Pheasants, Pigeons, Plovers, Quails, Rails, and Snipe.

Brought to Market.

Sclater gives the following as the birds commonly eaten or brought to market:—***Calandrella brachydactyla***, the *baghaira* Ortolan ; ***Charadrius fulvus***, the Golden Plover ; ***Chaulelasmus streperus***, the Gadwall ; ***Ciconia leucocephala***, the *manikjor* or Beefsteak Bird ; ***Columba intermedia***, the *kabutar* or Black Rock Pigeon ; ***Coturnix communis***, the Batter or Gray Quail ; ***Crocopus phœnicopterus***, the *hurrial* or Green Pigeon ; ***Dafila acuta***, the Pintail ; ***Eupodotis edwardsii***, the *tokdar sohan* or Bustard ; ***Francolinus pictus***, the Painted Partridge ; ***Francolinus vulgaris***, *kalatitur* or Black Partridge ; ***Fuligula nyroca***, the White-eye ; ***Fuligula rufina***, the Red-crested Pochard ; ***Gallinago gallinaria***, the Common Snipe ; ***Gallinago strenura***, the Pin-tailed Snipe; ***Galloperdix spadiceus***, the Red Spur-fowl ; ***Gallus ferrugineus***, the *jungli-murgi* or Jungle Fowl ; ***Gallus sonnerati***, the Gray-fowl ; ***Grus antigone***, the *sarus* or *sarus*-Crane ; ***Houbara Macqueeni***, the Houbara Bustard ; ***Hydrophasianus chirugus***, the Pheasant-tailed Jacana ; ***Nettapus coromandelianus***, the Cotton-teal ; ***Ortygornis gularis***, the *bantitar* or Kyal Partridge ; ***Pavo cristatus***, *mor* or Peacock (*Taleef Shereef*, *l.c.* 158) ; ***Pterocles exustus***, *kuhar* or Sandgrouse ; ***Querquedula circia***, the Blue-winged or Garganey Teal ; ***Sypheotis bengalensis***, the *charas* or Florican ; ***Totanus calidris***, the Red shanks or Snippet ; and ***Totanus glareola***, the Spotted Sandpiper or Snippet.

With slight modifications to meet local supplies, the above enumeration is representative of the traffic throughout India. For particulars consult the further popular sections given below concerning the Edible Birds.

D.E.P., v., 497. Ortolan.

(*c*) ***Ortolans.***—The true Ortolan (***Emberiza hortulana***) occurs only occasionally in India, but the substitutes for it are the *bargel*—Social or Short-toed Lark (***Calandrella brachydactyla***), the *duri* Ash-coloured Finch-lark (***Pyrrhulauda grisea***) and other allied species abundantly met with on the plains of India. Buchanan-Hamilton (*Hist. Ant. and Stat. Beng.* (ed. Montgomery Martin), 1807–13, i., 226; ii., 148, 506; iii., 186) makes frequent mention of the ortolan.

D.E.P., vi., pt. i., 116–7, 195–7. Pheasants.

(*d*) ***Pheasants, Partridges, Jungle-fowl, etc.***—The ***Gallinæ***: *Taleef Shereef* (Playfair, transl.), 1833, 145; Blanford, *l.c.* iv., 64–146; Hume and Marshall, *Game-Birds*, 183 *et seq.*; *Journ. Bomb. Nat. Hist. Soc.*, xi., 228; xii., 573–7; xiii., 521; Ball, *Jungle Life Ind.*, 538; Sanderson, *Thirteen Years Among Wild Beasts*, 147; Forsyth, *Highlands Cent. Ind.*, 130–1; Finn, *Ind. Pheasants, etc.*, in *Ind. For.*, 1902, xxviii., 228, 277, etc.; 1903. xxix., 116, 205, etc., etc. (long and valuable articles).

Simla Supply.

Call-birds and Traps.

Game Laws.

Excluding the poultry from present consideration, there are something like 60 species of wild pheasants, partridges, etc., which are systematically shot and eaten. The majority inhabit the hills, and are, therefore, but rarely seen in the bazárs of the larger towns of the plains. In Simla, for example, there is a regular supply of the *chír*, *kálij*, and *monál* pheasants; of partridges the *ban-titur* or *kaindal*, and last but by no means least, the *chakor*. The horned pheasant—*jewar* or *argus*—as it is sometimes called, is also occasionally seen. These and many others are included by the Sanskrit authors under the category of *vishkira* or birds which scatter their food. The *Ain-i-Akbari* (Gladwin, transl., i., 267; ii., 136; also Blochmann, transl., i., 63) mentions several forms and alludes to the practice of catching them by means of call-birds, a method pursued to the present day. One or two are favourite cage birds, especially the quail, and are reared for the purpose of fighting (Ainslie, *Mat. Ind.*, 1826, i., 288). Others are much prized on account of their plumage (*e.g. monál* and *argus*). No information exists as to the extent of the traffic in these birds, but it may be affirmed that the huge annual slaughter has for many years called urgently for the protective game-laws which have only just come into operation. [The following publications, assorted provincially, will be found to contain useful local particulars:—PANJÁB: *Settl. Repts. Hazara*, 1868; *Bannu*, 1879; *Ludhiana*, 1878–84. Game-birds, pheasants, etc., are frequently mentioned in the *Memoirs* of Baber, written about 1519, and the *lujeh*, to which he makes special reference (320), appears to be the *monál*. CENTRAL INDIA: Forsyth, *l.c.* 1889, 54–7. KASHMIR: Lawrence, *l.c.* 118. UNITED PROVINCES: *Gaz.*, iv., 243. BOMBAY: *Gazetteers Kaira, Panch Mahals, Ahmedabad, Ratnagiri, Thana, Kanara, Belgaum, Dharwar, Satara.* MYSORE: Rice, *Gaz.*, i., 155.]

D.E.P., vi., pt. i., 230–1. Pigeons.

(*e*) ***Pigeons and Doves;*** Blyth, *Ann. and Mag. Nat. Hist.*, 1847, xix., 104; Darwin, *Animals and Pl. under Domes.*, 1868, i., 131–224; Rice, *Squab Raising*, in *Farmer's Bull.*, *U.S. Dept. Agri.*, 1903, No. 177; Blanford, *l.c.* iv., 1–52. It does not seem necessary to deal with this subject very fully. There are some 40 wild species known and valued, and in domestication practically all the breeds met with in Europe are to be found in India, and a few seem even to have originated in that country.

Methods of Rearing and Training.

Tumblers.

Fantails.

Pigeons are closely connected with certain traditions of the Muhammadan faith, hence the birds are often protected in certain localities, such as at Mecca. They have been reared for pleasure from the earliest times of the Moslem nobility of India. Baber (*Memoirs*, 7) tells the story of the death of Omer-Sheik Mirza in 1494, through having been precipitated from his pigeon-house. In the *Ain-i-Akbari* (1590) full details are given of the methods adopted for rearing and training pigeons. Tumblers, carriers, pouters, etc., are mentioned, but it seems doubtful if the *luckeh* or *luqqún* of the *Ain*, identified by Blyth as having been the fantail, was so or not, though that name is commonly given to them at the present day. The *kokah* pigeon, the voice of which sounds like the call to prayer, and the *baghah*, which utters a peculiar sound in the early morning, as also the *yahu-yahu*, may have been trumpeters and laughers. The *lotan* was doubtless a ground tumbler. One of the special and much-prized features of Indian pigeons is the remarkable way they return to the dovecote on a certain signal being given.

Semi-wild.

In some Hindu towns, such as Jaipur in Rajputana, pigeons exist in a semi-wild condition. A race of the blue rock has simply been allowed to breed undisturbed for countless ages. This bird seems to differ from the English stock in having the lower part of the back ashy, instead of pure white, hence its separation as ***Columba intermedia.*** Baber speaks of the Indian rock-pigeons as being smaller and more slender than the Central Asiatic bird, and as having a sharper cry.

Food.

Pigeons are much valued by many classes of people as FOOD, and the traffic in them all over India must be exceedingly great. They are usually brought to market alive, and fed from day to day by the traders. In Calcutta they are stored in large flat baskets, the owner feeding them by squirting from his own mouth into the gullets of the birds, one by one, a small quantity of grain and water. [*Cf. Settl. Rept. Jhelum*, 1883, 20 ; E. H. A., in *Times of India*, May 1899.]

Common Fowl.

(*f*) ***Poultry and Eggs.***—This may be accepted as embracing the Domestic or Common Fowl, the Guinea-fowl, the Turkey, Ducks, Geese, Pigeons, etc. Since some of these birds are discussed in this article under their respective names, the present remarks may be restricted to the FOWL.

Origin of.

It is fairly generally accepted that all the Domestic Fowls of the world have been derived from ***Gallus ferrugineus***, a bird met with in its wild condition throughout the lower Himalaya from Kashmir to Assam, and from the mountains of Burma to the Malay Peninsula, Sumatra, Siam and Cochin-China. It would seem probable that it was first domesticated in the Malay and introduced into India in that condition. It is mentioned in the *Institutes of Manu*, and appears to have reached Europe about 600 B.C. The wild bird, it has been observed, when reared in captivity or when crossed with the domestic fowl, is more fertile when procured from the east than from the west of the Bay of Bengal. A few special breeds may have originated in India, such as the Chittagong and the Sooty Fowl. Examples of the Frizzled Fowl (a bird with the feathers curled backwards) and of Jumpers are not uncommon, the latter more especially in Burma.

Crosses of Wild and Domestic Stock.

Indian Fowls of to-day.

Considering the importance of the subject, remarkably little of a trustworthy nature has been published regarding the Indian domestic fowls. Ibn Batuta, Marco Polo, Varthema, Linschoten, Dampier and many other early travellers make special reference to the quality, size, and abundance of Indian fowls. Hove (*Tours in Gujarat, etc.*, 1787, 80) says: "In this country fowls are prodigiously large, and are called by the Europeans Colomb fowls. They breed them now about Surat in abundance. . . . Some of them are so large that they are often mistaken by strangers for turkeys." It is difficult to conceive why the early travellers in India so uniformly speak of the fowls seen by them as "large." The ordinary fowl of India to-day is a very small and very inferior representative of the fowl of Europe.

Chittagong Fowls.

Mention has been made of Chittagong fowls, and it may be added that it is customary to read of them as a peculiar and valuable race, characteristic of Eastern Bengal. In the Bengal Administration Report (1901–2), for example, the observation occurs that "the best poultry comes from Chittagong and the hill tracts, and are short-legged, large-bodied birds, much resembling English fowls." The "jumper" of Burma is an exceptionally short-legged bird, derived doubtless direct from the Chittagong breed. Further to the east, the Cochin-China breed would appear to have originated. Game-cocks have from time immemorial been specially reared in many districts of India, and in some localities cock-fighting has, from the most ancient times, been a favourite pastime. Sonnerat (*Voy. aux Ind. Or.*, 1782, v., 113) says he thinks the birds specially reared for cock-fighting are derived from the indigenous wild species,

Burma Jumper.

Cochin-China Fowls.

Game-cocks an Cock-fighting.

Capons.

Ethiopian Hen.

"Nigger-fowl."

Incubators anciently known.

and thus is led to believe that the domestic fowls ot the world may havo come from India. The special association of Chittagong, however, with the game-cocks of India has little more to justify it than the early association of the turkey with Calicut. Montgomery Martin, compiling from Buchanan-Hamilton, speaks of the people of Assam as keeping game-cocks (*E. Ind.*, iii., 671). Lawrence tells us that in Kashmir capons are specially reared for the table, but in India as a whole little or no attention appears to be given to special methods of breeding, feeding, etc., of fowls for the table as distinct from those reared for the supply of eggs. Bernier (*Travels*, 1656–68 (Constable, *Or. Misc.*), 1891, i., 251) attributes this to "the people being tender-hearted toward animals of every description, men only excepted." "The markets are amply supplied with fowls tolerably good and cheap. Among others there is a small hen, delicate and tender, which I call Ethiopian, the skin being quite black." Inspired possibly by Marco Polo, Linschoten (who was by no means as accurate an observer as Bernier) affirms that the flesh of the so-called Ethiopian as also the bones are black. [*Cf.* also Thevenot, *Travels in Levant, Indostan, etc.*, 1687, iii., 51.] Tegetmeier (*Poultry Book*, 265–8) gives full particulars of these so-called "Nigger-fowls" (the Sooty Fowls of some writers), and it need only be added that they are by no means common in India. John Leo (Africanus) (*Geog. Hist. Africa* (Pory, transl.), 1600, 314) describes the incubators in use in Egypt during the 16th century.

In the more populous parts of India (Bengal especially) fowls, like many other articles of food, have risen in price considerably within the past 20 to 30 years. At the beginning of that period four large or eight small fowls could have been purchased for one rupee, while at present they cost 4 to 12 annas or even one rupee each. [*Cf.* Scott, *Dom. Poult. known to the Jews, Mem. Wern. Soc.*, 1830, vi., 391–401; Wilson, *Orig. Dom. Poult.*, 402–16; Low, *Hist. Tenasserim, Journ. Roy. As. Soc.*, ii., 272; Anderson, *Mandalay to Momien*, 16; Hoey, *Monog. Trade and Manuf. N. Ind.*, 152; Voelcker, *Improv. Ind. Agri.*, 405; Lawrence, *Valley of Kashmir*, 365–6; Collett, *A.B.C. Guide to Rearing Poultry, Ind.*; Isa Tweed, *Poult. Keeping in Ind.*; *My Poult.*, by "The Indian Henwife"; Mackenzie, *Popular Poult. Keeping*; Wright, *The Book of Poult.*; Numerous writers in Indian public press such as in *Bomb. Gazette*, Aug. 1895; *Madras Mail*, Feb. 1896 (report on the *Dudar Poult. Farm*); *Ind. Agrist.*, Feb. 1898; McCue and Bradshaw, *Poult.*, in *Agri. Gaz. N.-S. Wales*, 1898, ix., 894–7, 1161–80; *Planters' Gaz.*, Oct. and Nov. 1899; *Pioneer*, article by "Camellia," Feb. 1900; *Ind. Agrist.*, May 1900 (a report on *Poult. Rearing in Beng.* at the Model Farm of Pakur); *Poult. in West Ind.*, in *Imp. Dept. Agri.*, Pamphl. No. 23, etc., etc.]

D.E.P., i., 160

Eggs.

Indian Supplies.

Price.

Albumen.

China Trade.

Yolk.

TRADE IN EGGS.—Mention has already been made of the production of Ducks' eggs in Madras Presidency for the Burmese market. Though all large towns have regular supplies of eggs, nothing can be learned as to the sources on which they depend. It would thus seem as if every great centre produced its own fowls and eggs, within its immediate neighbourhood. In the official publication *Prices and Wages in India*, certain particulars are furnished regarding eggs in the Western Presidency. A rise in price has on the whole taken place, but in Bombay town this is not material, as eggs sell at 4 to 5 annas a dozen. Taking the years 1871–75 as being 100, they sold in 1901 at 107, in 1902 at 100, and in 1903 at 103; in Sind at 127; and in Central India and Rajputana at 118. The traffic in Egg Albumen is important. An article in *The Indian Agriculturist* (Feb. 1898) reviews an account that appeared in a Burma paper of the Chin-hiang China trade in that substance. Ducks abound in the neighbourhood, flocks of 4,000 to 5,000 being not uncommon. The eggs are broken and the white separated from the yolk. The white or albumen is used in dyeing, being largely exported for that purpose to Europe, and the yolk, used in the dressing of certain leather, is in much demand in Europe. *The Diplomatic and Consular Report* (1901, No. 2601, 10) gives the returns of the Chinese traffic in egg-yolk. It rose from 13,788 to 22,533 cwt.

Preservation of Eggs.

[*Cf.* Ainslie, *Mat. Ind.*, 1826, 117, 288; O'Shaughnessy, *Beng. Disp.*, 686–7; Royle, *Prod. Isinglass*, 5; Honigberger, *Thirty-five Years in East*, ii., 320; Waring, *Pharm. Ind.*, 281; Simmonds, *Waste Prod.*, 1876, 118; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 152; Hendley, *Med. Top. Jeypore*, 1895, 67; Lawrence, *Valley of Kashmir*, 1895, 366; *Ind. Agrist.*, Feb. 1, 1898; *Journ. Board of Trade*, Sept. 1899, vi., 149–56; Dec., 362; many newspaper articles on preservation of eggs, on the testing their freshness, etc., have appeared in the Indian press, mostly reprinted from European, American and Australian publications. No writer has, so far as I can discover, given particulars of the Indian markets or of Indian experience.]

D.E.P., vi., pt. i., 378. Quail and Snipe.
Handled cruelly.

(*g*) ***Quail, Snipe, Plovers, Florican, etc.***—When speaking of the plains of India the quail and snipe are by far the most important of the game birds. The former are often captured in great quantities and sent alive all over India, and the latter are both trapped and shot. As a protective measure, it may be added that some of the railways refuse to carry live snipe, since the birds do not eat after being captured, and are often handled most cruelly; for example, to prevent them fighting or escaping, they are blinded or otherwise disfigured. It is to be hoped, therefore, that very shortly, under the new Act, measures may be enforced even more stringent than the humane action of the railway companies. The florican is valued as much for its rarity as for the delicacy of its flesh. [*Cf.* Ainslie, *l.c.* i., 392; Hunter, *Imp. Gaz. Ind.*, vi., 1886; John Burke in *Field* (reprinted in *Times of Ind.*), Nov. 28, 1899; *Snipe-Shooting in Ind.*, *Englishman*, Feb. 10, 1902; E. H. A. in *Times of Ind.*, July and Aug. 1899.]

D.E.P., ii., 504-9. Edible Nests.

4. **Birds: Edible Nests** (*Collocalia francica* and *C. fuciphaga*); Blanford, *Fa. Br. Ind.*, iii., 175-9; Jacobus Bontius, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 66; Forrest, *Voy. New Guinea*, 1780, 28; Milburn, *Or. Comm.*, 1813, ii., 306; Crawfurd, *Journ. to Ava*, 1834, ii., 178; Royle, *Prod. Isinglass*, 1842, 53; Griggs, *Man. Nilgiri Dist.*, 159; Carpenter, *Rec. Geol. Surv. Ind.*, 1888, xxi., pt. i.; Hickson, *Nat. N. Celebes*, 1889, 49-50; Portman, *Journ. Photo. Soc. Ind.*, 1892; H. Warington Smyth, *The Wide World Mag.*, 1898, 288-93; Foreman, *Philippine Islands*, 1899, 366. Edible nests are known in Hindustaní as *ababil-ka-ghoslah*, in Nicobar as *hikai*, and in Burma as *gnathiet*.

Three Kinds.

A fairly detailed account of this curiously interesting edible product will be found in the *Dictionary*. That article was compiled very largely from a report by Mr. Portman regarding the Andaman, and one by Mr. de Rœpstorff on the Nicobar supplies. Blanford tells us that ***C. francica***, the Little Grey-rumped Swift, affords the purest quality of edible nests. It is met with on the coasts of Tenasserim and Arakan, as also on the rocks in the Andaman and Nicobar Islands. The breeding season is in March. The nests produced by ***C. fuciphaga*** (= ***C. nidifica***) are found in Ceylon, the Malabar Coast, the Nilgiri and Anamalai hills, etc. Its breeding season is March to June. The former bird gives nests quite free from grass, moss or feathers, the latter is much adulterated with the substances named, which are simply cemented together by the inspissated saliva.

Earliest Description.

Jacobus Bontius was perhaps the first European writer who described the edible swallow's nest. He gives an excellent picture, and says the nests are sold in great quantity throughout India. He regarded them as made from the foam of the sea. Mandelslo (*Travels Ind.*, 1639, 134), speaking of the Malay, says that the swallows' nests were found "on rocks by the seaside, and are of such esteem in China that they sell them for 3 or 4 crowns the lb." It is probable that Volkamer (*Nurnb. Hesper.*, 1714, ii., 236) is also alluding to this substance when he speaks of the chickens that spin fibre out of their mouths. Milburn says edible nests are found in caves on the sea-coast of Sumatra, Java and many of the Eastern Islands. "The cleanest and best are almost as white as writing paper and as transparent as isinglass." "They should be perfectly dry; if so crisp as to break, it is the better."

Trade.

The merchants who trade in this substance are Chinamen resident in Rangoon. The nests are assorted into three classes and then exported to China. The finest qualities go to Pekin. The Japanese do not use these nests, but they are said to fabricate an artificial nest from seaweed which is sent to China. The trade seems to be declining, as shown by the steady diminution of the sum paid in Burma for the right to work the supplies (see **Manures**, p. 769: **Isinglass**, p. 695).

D.E.P., i., 430; iii., 321 2. Uphol-stery.

5. **Birds: Industrial.**—The materials that fall under this position are briefly—Bird-skins, Feathers, Guano and Quills. The first two may be taken collectively and the third will be found under **Manures** (see p. 769).

(*a*) ***Bird-skins and Feathers.***—It is customary to discuss feathers

Ornament.

Skin collection.

under :—COMMON FEATHERS used for upholstery ; DOWN used for Quilts ; ORNAMENTAL FEATHERS and QUILLS. In India the feathers of the domestic fowl are almost universally destroyed through the habit of removing them after immersion in hot water. Were an effort made to remedy this defect, India might supply a large quantity of upholstery feathers. The same remark is applicable to the supply of down. Ornamental feathers are usually referred to three classes :— (*a*) those like the ostrich plumes whose barbules are long and loose, giving beauty of form ; (*b*) those in which the plumes are decomposed, as in the egrets ; and (*c*) those that manifest great beauty and brilliancy of colour (see below under **Plumage**). Balfour (*Cyclop. of India*) appears to be the only writer who has so far afforded particulars of the feather industry—fortunately an industry of historic but not of great future intrinsic value. He tells us that " the Madras dealers in birds' feathers used to carry on their trade on an extensive scale. One dealer had nearly 100 sets of hunters, each composed of four or five *shikaris* and one cook ; most of these people are *koravas* (basket-makers) who live in and about Madras. Each set has its head man, who is responsible for the others. The sets are sent out once a year, each receiving from Rs. 20 to Rs. 100 together with a number of nets, a knife, etc. They traverse all India, collecting the feathers of kingfishers, etc." " They bring back from 1,000 to 6,000 skins which are exported to Europe, Burma, Penang, Singapore and Malacca." The blue jay feathers are much in demand in China.

Ostrich Farming.

(*b*) ***Ostrich.***—Some few years ago an effort was made to establish ostrich farming in India (near Agra) but with little or no success. Mention has recently been made of Mysore as a favourable locality, a suggestion inspired by the great success of the Australian farms. [*Cf. Madras Weekly Mail*, Aug. 1899 ; *Pioneer*, Sept. 1903 : for Food to be given to Ostriches, see **Agave**, p. 35.]

Plumage.

(*c*) ***Plumage-Birds.***—The following, it may be added, are the chief birds killed in India on account of their plumage, the particulars given being abstracted very largely from Blanford. A certain amount of grouping has been attempted in order to save space; thus all the paroquets are brought together, all the bustards together, etc., etc., the assortment being otherwise alphabetical according to the scientific names of the birds or groups of birds :—

Blue Heron.

Paddy-birds.

Cattle Egrets.

Ardea cinerea (*Fa. Br. Ind.* (*Birds*), iv. 382 *et seq*), the Common or Blue Heron, the *nari, anjan, sain*, etc. ; ***Ardeola grayi***, the Pond Heron or *bagla, khonch-bogla, kokku*, etc. A common and familiar bird of rice-fields and village tanks—often called the Paddy-bird; also ***Bubulcus coromandus***, the Cattle Egret or *surkhia-bagla, gai bogla, huni koku*, etc. This egret is a constant attendant on cattle and feeds on the insects that are attracted to them. Sclater groups these three herons together as birds that produce feathers which are sold in large quantities, but which do not fetch such high prices as the egrets proper.

Kingfishers.

Ceryle varia (*l.c.* iii., 119), the Indian Pied Kingfisher, the *koryala-kilkila* or *karikata* ; ***Halcyon smyrnensis*** (*l.c.* iii., 132), the White-breasted Kingfisher or *kilkila, khandu, machranga*, etc. ; ***Pelargopsis gurial*** (*l.c.* iii., 129), the Brown-headed Kingfisher, *gurial, badami*, etc. These and several other kingfishers, such as ***Alcedo ispida***, *chota kilkila*, ***A. grandis***, the Great Indian Kingfisher, and ***Ceyx tridactyla***, the Three-toed Purple Kingfisher, are all extensively slaughtered for their skins. Hunter (*Stat. Acc. Beng.*) makes special mention of the traffic in the skins of kingfishers from Tippera and Chittagong to Burma and China. Mr. C. M. Inglis says that in Darbhanga there is a village of 16 houses, all concerned in the bird-skin trade. One man told him that on an average he snared at least 100 kingfishers during the season, the skins fetching Rs. 15 to Rs. 20. This for the entire village would make a destruction of thousands a year. Decoys are used, namely, live birds with their eyes sewn up.

Roller.

Coracias indica (*l.c.* iii., 103), the Indian Roller, the Blue Jay of Europeans or *nilkant, sabzak, tás, pálú pitta, kattu kadei.* As already mentioned, this is perhaps the most extensively killed for its beautiful plumage of all the Indian birds, and as it is helpful to the cultivators, its destruction is to be greatly deplored.

Bustards.
Plumes.
Florican.

Eupodotis edwardsii (*l.c.* iv., 192 *et seq.*), the Great Indian Bustard, the *sohun, hukna, hum, tokdar, tugdar, bat-meka, kanal-myle,* etc. Met with throughout India except in Bihár, Chota Nagpur, Orissa, Bengal. It is usually found singly or in twos or threes, and keeps chiefly to the open dry country, especially wastes covered with low grass and scattered cultivation. It feeds on insects, especially grasshoppers, small reptiles, fruit, grain, shoots of grass, etc. In the *Ain-i-Akbari* mention is made of the *okar* feathers of Kashmir. Baden-Powell gives the name *onkar* to the feathers used in making *kalgi,* the plumes of the *khod* or helmet. These were probably the black feathers of a Bustard, or of the Snake-bird (see below). ***Houbara Macqueeni***, the Houbara bustard or *hobára, tilur, talur,* etc. A cold-weather visitor to North-Western India, Panjáb, Sind, Rajputana, Kach and Northern Gujarat. ***Otis tetrax***, the Little Bustard or *chota tilur,* met with in the Panjáb. Lastly, ***Sypheotis aurita***. the Lesser Florican or *likh, chota charat, charas, barsáti, ker mor, tan-mor, chini-mor, niala nimili,* etc. Also ***S. bengalensis***, the Bengal Florican. These birds are found at times throughout India from the Himalaya to Cape Comorin, but the former chiefly inhabits the Peninsula south of the Godavari in winter, and breeds in the Deccan, Western and Central Provinces, Central India, Rajputana, etc. The latter occurs in the country from the foot of the Himalaya and the Ganges to the plains of Assam. Blanford observes of the former that the numbers are being greatly reduced by the unsportsmanlike practice of shooting during the breeding season. And of the latter he remarks that it is one of the most delicious of game birds.

Delicious
Game Birds.

But it may be said that most of the above-mentioned birds are or rather have been killed on account of their plumage as well as for their flesh. Bustard feathers constantly appear in the Madras trade reports.

Jungle-fowl.

Gallus ferrugineus (*l.c.* iv., 75), the Red Jungle-fowl or *jangal-murgh* (male), *jangli-murghi* (female); common throughout the Lower Himalaya from Assam to Kashmir. Also ***G. sonnerati***, the Grey Jungle-fowl or *komri, koli,* etc., of South, West and Central India.

Manufacture
Fishing flies.

The wild fowls, though killed mainly for food, afford skins that are as a rule preserved and sold. The wild fowl of South India is specially valued for making artificial fishing-flies; its golden or ferruginous spotted feathers are unsurpassed for certain purposes, and fetch higher prices than do most other feathers met with in the market.

Large Egret.
Seasons.
Decompose
Feathers
Aigrette.

Herodias alba (*l.c.* iv., 385), the Large Egret, *mallang-bagla, tar-bagla, bara-bagla, pedda-tella-konga, mala-konga, vella-koku,* etc. Found throughout India and Burma; often seen solitary but in association with either of the next two species. In North India and Burma it breeds in July and August, and in the Karnátak in December to February. Also ***H garzetta***—the Little Egret or *kilchia, nella-nucha-konga.* Common throughout India and Burma. Lastly ***H. intermedia***. the Smaller Egret. *patokha bagla, patangkha,* etc. Met with throughout India and Northern Burma. The breeding season is the same as that of the large egret. These pure white, slim herons develop temporarily during the breeding season a dorsal train of feathers, which elongates and becomes "decomposed," as it is expressed, that is to say, the barbs are separate and distant from each other. thus forming the ornamental plume or aigrette for which these birds are much sought after and ruthlessly destroyed.

Trade.

The present trade in Egret and Bustard feathers seems to be chiefly in the hands of Madras traders. Some time ago Commercolly in Bengal was famed for its egret feathers, and these were used for head-dresses, tippets, boas and muffs. Although this trade still exists in Darbhanga, Purneah and Maldah, the birds are becoming very scarce. It would seem that at the present day the chief Indian supply is from Madras.

Adjutant.

Leptoptilus dubius (*l.c.* iv., 373), the Adjutant, or *hargilá, garur, chaniari dhauk, dusta, pinigala-konga, don-zat, pir-e-dang,* etc. A useful scavenger that

Marabout or Commercolly Feathers.

used formerly to frequent Calcutta and is still met with at the Salt Lakes and has been found in immense herds in Burma. The down of the young adjutant bird is (or rather was formerly) made into ladies' boas and victorines. The under-tail coverts are collected and sold in considerable quantity. They are known in trade as Marabout or Commercolly feathers, and seem to be procured at present mainly from Tirchoor and Malabar, though formerly the traffic was chiefly from Commercolly and Nadiya to Calcutta. It is described by Ælian (A.D. 250); Baber (*Memoirs*, 1519–25, 321) and Ball (*Jungle Life*, 82) both refer to the snake-stone said to be found in the head of this bird.

Monals.

Lophophorus refulgens (*l.c.* iv., 96), the *monál, nil, lont* (male), *karari, ham* (female), *nil-mor, nilgur, datiya,* etc. An extremely beautiful and large pheasant found throughout the Himalaya, from Chitral and Kashmir to Bhutan, at altitudes of from 9,000 to 15,000 feet, except in the winter, when it may be found at 5,000 feet. Skins of the cock birds are extensively traded in all over India, and a fairly large number are annually exported, the supply received at Calcutta coming mainly from Bhutan and Nepal. Sclater tells us that he has seen as many as 1,000 skins offered for sale at one time.

Paroquets.

Palæornis cyanocephalus (*l.c.* iii., 251–9), the Western Blossom-headed Paroquet, the *tuia-tota, faraida, kir,* etc. A fairly plentiful bird in the forests of the lower Himalaya and Peninsula of India. ***P. fasciatus***, the Red-breasted Paroquet, the *madna, kájla, gour-tota,* etc. Himalaya up to 5,000 feet from Kumaon to Assam, Manipur, Burma, Cambodia, Cochin-China, etc. An inhabitant of well-wooded tracts, but visitant of the intervening fields. ***P. nepalensis***, the Large Indian Paroquet or *chandana*, a bird met with plentifully in Northern and Central India, the lower Himalaya, the Northern Circars, Kangra and Mount Abu to Bengal. ***P. rosa***, the Eastern Blossom-headed Paroquet, the *kyay-ta-ma* of Burma. Lastly, ***P. torquatus***, the Rose-ringed Paroquet or *tota, lybur tota, tiya tota, ragu, chilluka, killi, kyay-gyot,* etc. This is by far the most plentiful paroquet of India, and abounds near towns and houses and prefers open cultivated lands to forest tracts. It often does much damage to field and garden crops. It is very frequently kept as a pet, and is a very docile and loquacious bird. Baber (*Memoirs*, 319) gives a long account of the various birds of this kind that were taught to speak by the people of India in his day (early in the 16th century).

Speaking Birds.

Most of the above species of paroquets are extensively killed on account of their skins, but since they are very abundant and often very destructive, little regret need be expressed at their being annually killed off to a certain extent. Paroquet skins are largely exported from Hill Tippera.

Peafowl.

Pavo cristatus (*l.c.* iv., 68), the Common Peafowl, the *mor, mahr, manja* (male), *manir* (female), *myl, nimili, nowl,* etc. Plentiful throughout all the drier tracts of India. It ascends the Himalaya to 2,000 feet in altitude. Abounds in Gujarat (a fact specially mentioned by Thevenot in 1687), Kach, and Rajputana, and being protected, since regarded by certain Hindus as sacred, it frequently does much damage to the fields. The males moult their long trains after the breeding season, about September, and the feathers are collected by the villagers and sold, but in many parts of the country large numbers are killed, and their feathers and complete tails sold to the dealers. In *Indian Art at Delhi* (1903, 198–9) particulars will be found of the artistic use of peacock feathers. They are largely employed in ornamental work, such as the manufacture of fans, *morchals, chauris,* braids, etc. Some few years ago a large trade was done in peacock-feather braids, which were used in trimming dresses and for other such purposes. The chief centres of manufacture are Agra, Aurangabad, Benares, Jhansi, Mysore, Nepal and Savantvadi. Peacock feathers seem to be exported mainly from Bombay. [*Cf.* Baber, *l.c.* 318; Ainslie, *Mat. Ind.*, 1826, i., 290.]

Moulting Season.

Peacock Feathers.

Braids.

Snake-birds.

Plotus melanogaster (*l.c.* iv., 344), the Indian Darter or Snake-bird, the *banwa, pan dubbi, goyar,* etc. This bird exists throughout India and Burma, wherever fairly extensive lakes, marches, etc., of fresh water or large rivers with slow currents occur. According to Jerdon the lengthened scapular feathers are looked on as a badge of royalty by the Khasias, and were once the badge of one of the Bengal regiments of Irregular Cavalry. The birds are killed on account of these feathers, which formerly were fairly extensively exported.

The Argus Pheasants.

Tragopan melanocephalus (*l.c.* iv., 100), the Western or Simla Horned Pheasant, *jewar, jaghi, sing-monal, jigurana* (male), *bodal* (female), *falgur,* etc.

North-West Himalaya from Garhwal to Hazara. ***T. satyra***, the Crimson Horned Pheasant, the *lungi, omo, bap, tar-rhyak*, etc. Eastern Himalaya from Garhwal to Bhutan. These two pheasants are sometimes called the Argus by European sportsmen, and their skins are generally sold under that name—the true Argus occurs in the Malay Peninsula.

Hoopoe.

Upupa epops (*l.c.* iii., 159), the European Hoopoe and ***U. indica***, the Indian Hoopoe or *hudhud, sutár, kondeh pitta, chaval kuruvi, toun-bee-sote*, etc. The former is met with in the Himalaya and on the plains of Northern and Central India, and the latter throughout India and Burma, except Sind and the Western Panjáb. Both birds are extensively slaughtered on account of their plumage. [*Cf.* E. H. A. in *Times of India*, Sept. 29, 1899.]

Trade in Birds, Skins, etc.

Trade.

(*d*) ***Feathers.***—The above are the chief birds killed for their brilliant feathers, but all birds with bright-coloured plumage may be and occasionally are killed for that purpose, such as the honey-suckers, bitterns, jays, water-hens, bee-eaters, orioles, shrikes, bulbuls, grebes and hornbills. The trade in these and such-like is a very ancient one. Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 200), speaking of Tenasserim, alludes to the sword-hilts made of the helmet-hornbill. The modern trade in feathers of all kinds fluctuates greatly. In 1880-1 the exports were valued at Rs. 2,69,447; in 1884-5 at Rs. 6,33,017; in 1887-8 at Rs. 5,70,495; in 1895-6 at Rs. 5,55,185, since which date it appears to have declined materially; in 1900-1 it stood at Rs. 1,35,440; in 1901-2 at Rs. 1,79,618; in 1902-3 at Rs. 88,691; in 1903-4 at Rs. 5,093; in 1904-5 at Rs. 880; in 1905-6 at Rs. 4,416; in 1906-7 at Rs. 1,437. In former years the major portion of these exports went usually to the United Kingdom, which took in 1895-6, Rs. 4,18,006; in 1902-3, Rs. 60,000; and in 1906-7, *nil*. More recently to China (Hongkong), which took in 1895-6, Rs. 58,562; in 1902-3, Rs. 23,387; and in 1906-7, Rs. 1,350. Practically the balance on these valuations of the total for the years in question goes to the Straits. The imports of feathers are unimportant. As a natural consequence of recent legislation the portions of this traffic concerned in the foreign supply will be discontinued.

Legislation.

D.E.P., vi., pt. i., 387.

(*e*) ***Quills.***—The traffic in bird-quills is unimportant. Peacock quills are used in embroidering leather, as for example in the small boxes made at Bilaspur and Anandpur in the Panjáb, etc. Porcupine quills are to a small extent employed in South India, mainly in veneering fancy boxes.

D.E.P., i., 454-7. Arnotto Dye.

BIXA ORELLANA, *Linn.*: *Fl. Br. Ind.*, i., 190; Pomet, *Hist Drugs*. (Engl. ed.), 1712, 224; Gamble, *Man. Ind. Timbs.*, 38; Cooke, *Fl. Pres. Bomb.*, i., 53; Duthie, *Fl. Upper Gang. Plain*, i., 58; Burkill, *Agri. Ledg.*, 1904, No. 12; BIXINEÆ. The Annatto or Arnotto, *roucou. urucu* (Brazil), *latkan, koug kuombi, jarat, kisri, jafra, kuragú-mangjal, rangamali, thi-din.*

Introduction into India.

A shrub originally a native of America and now largely cultivated in India for the dye afforded by its seeds. It is very common in S. India, and believed to be there almost completely naturalised. Hove speaks of its cultivation in Bombay in 1787, and Buchanan-Hamilton (*Stat. Acc., Dinaj.*, 1833, 155) mentions that "the *Bixa*, an American plant, is now rapidly spreading over Bengal." Occasionally planted for ornament, especially in Ceylon; the least touch of frost is fatal, but it will grow almost anywhere within the tropics where the rainfall is 50-60 inches. The plants make a good hedge or wind-break.

Two Forms.

There are two forms, one having white flowers and greenish capsules, the other pink flowers and red capsules. The pink-flowered form is viewed as most desirable though it is not always the most easily grown, although one or other exists throughout tropical India. Fuller particulars of the distribution and cultivation will be found in Mr. Burkill's *Review of Existing Knowledge*

Dye.
Cheese-colouring.
Fibre.
Medicine.

Pomet gives an admirable drawing showing the plant and a *roucou* factory. The pulp surrounding the seeds gives a beautiful flesh-coloured DYE largely used for silks. In combination with the red powder of ***Mallotus philippinensis***, a bright orange-red colour is obtained. The dye is exported to Europe from the West Indies to be used in colouring cheese, chocolate, etc. It may be extracted from the seeds direct, or the pulpy matter may be separated by boiling and made into cakes—the usual commercial form in Europe. The cakes are wrapped in the leaves of the banana and known as *flag-annatto*. The West Indians are said to rub the pulp off in their hands, and by adding lemon-juice and gum make crimson paint for their bodies. The mordant employed with arnotto is usually crude pearl-ash: the alkali facilitates solution but affects the colour. The dye is fleeting and is chiefly used for silk, but to some extent also for cotton-cloths, *e.g.* in Cachar. The Mánipúris are said to avail themselves of the fruits of ***Garcinia pedunculata*** to deepen the colour of the silk after dyeing with *arnotto* and also to fix it. The latter suggestion needs verification, since the dye is not as a rule considered fast. The bark yields a good FIBRE used for cordage in the West Indies. In MEDICINE the seeds are regarded as astringent and febrifuge. The friction of two pieces of the wood is reported to produce fire very easily, and for this purpose is used by the West Indians.

Prices of Dye-cake.

The best Cayenne ("cake") *arnotto* fetches in France about 200 francs per 100 kilos, and in Germany about 80 marks per 100 kilos. Its use has been ousted from India to a great extent by the introduction of aniline dyes, and the demand is perhaps too small to encourage export. In the Toronto Exhibition leaflet (1902) it is stated that the value of the exports from Jamaica in 1900 amounted to £5,800. From the London market reports for 1903 (in *Brit. and Col. Drug.*; or *Chem. and Drug.*) it would appear that from 2½*d.* to 4*d.* per lb. is obtainable for best Madras seed, but that the demand is very limited. It may be mentioned that the average production per acre is about 6½ to 7½ maunds of seed yielding some 26 to 30 seers or rather under 1 cwt. of dye. [*Cf.* Taylor, *Topog. Stat. Dacca*, 1840, 143; De Candolle, *Orig. Cult. Plants* (Engl. ed.), 1884, 401; Lawson, *Pharm. Journ. and Trans.*, 1885–6, 645; Watt, *Select. Rec. Govt. Ind.*, 1888–9, i., 55; *Pharmacog. Ind.*, i., 149; *Kew. Bull.*, 1890, No. 48; Ferguson, *All about Aloe and Ramie*, 1890, 54; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 38–9; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 47; Thorpe, *Dict. Appl. Chem.*, 1898 i., 173; *Cat. des Pl. Econ. Colon.*, "*L'Hort. Colon.*," Brussels, 1900, 44; Jackson, *Pharmaceut. Journ.*, April 4, 1903; *Bull. Union Agri. Caled.*, 1903, ix., No. 75, 6–7.]

D.E.P.,
i., 461 84;
vi., pt. i.,
443-84.
China-grass.

BŒHMERIA NIVEA, ***Gaudich*; *B. nivea*, var. *tenacissima*,** *Miquel*; *Fl. Br. Ind.*, v., 576; Buch.-Ham., *Stat. Acc., Dinaj.*, 194; Watt, *Rhea and Allied Rhea Fibres*, in *Select. Rec. Govt. Ind.*, 1888–9, i., pt. ii., 283; Rein, *Indust. Japan*, 1889, 167–8; Michotte, *Traité de la Ramie*, 1891; Hosie, *Three Years in W. China*, 1890, 73–4; Watt, *Bœhmeria nivea—Rhea and China Grass*, *Agri. Ledg.*, 1898, No. 15; Bretschneider, *Hist. Europ. Bot. Disc. China*, 1898, 42, 99, 133, 495–6, 770; Wray, *Ramie Cult. in Perak*, *Mus. Notes*, 1898, ii., 103–24; Barraclough, *Ramie, Rhea, China-grass, etc.*, in *Text. Merc.*, (a series of articles), May 26 to June 16, 1900; *Der Tropenpflanzer*, 1902, vi., 185–90; Frank Birdwood, *Journ. Soc. Arts*, 1904; *Ramie*, *Dipl. and Cons. Rept.*, 1904, No. 3280, 54; Bothier, also Bigle de Cardo, *La Ramie*, in *L'Agri. Prat. des Pays Chauds*, 1902-3, ii., 176–97; 1904, iv., 335–54; 1905, v., 56–67; Coventry, *Rhea Exper. in India*, *Agri. Journ. Ind.*, 1907, ii., pt. i., 1–14; *Kew Bull.* (numerous passages); Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 90–1.

It seems doubtful if the two forms indicated by the above-mentioned names can be botanically regarded as anything more than climatic or geographical races of one species. The practical value of their separate recognition may however be accepted as at once demonstrated by the circumstance that the one—the China plant—has been grown in the open air in England and regularly sown as a field crop in the south of

Europe, while the other—the Malaya plant—can only be raised under glass, so far as Europe is concerned. The distinction ought therefore to prove of considerable value to Indian prospective cultivators. In fact it seems possible that some share of past failures may be due to Indian experimentalists having forced the cultivation of the tropical plant in temperate areas. That being so, it may be useful to set forth the two forms separately, but the reader should consult *The Agricultural Ledger* (above mentioned) for the botanical synonyms of the plants in question :—

China-grass or Rhea.

α **Var. nivea** proper; Watt, *l.c.* 8, t. 1. The China-grass or Rhea of commerce bears the following local and vernacular names :—*chu-ma* in China; *cay-gai, pa-ma* in Cochin-China; *kankúra* (rarely *kund* or *kurkund*), in Bengal; *reeha* (*ríha*) or *rísa* in Assam; *pan* in the Shan States, and *gun, gwon* in Burma (*ma*, see **Cannabis**, p. 251).

It will be seen by a comparison with the Malayan names recorded as more especially applicable to the second variety below, that very possibly the only truly indigenous Indian names in the above enumeration are *kankúra* and *ríha.* Further, the latter name is perhaps only a modern translation from one plant to another of the word *risa*, the Naga name for a fibre-yielding plant which has recently come to be spoken of as the *ban-riha* or wild-*riha* of Assam (see **Villebrunea**, p. 164). In part support of this idea it may be added that the people who use the *ban-riha* fibre grow the true *riha* plant, but only as an article of export—they never use that fibre themselves, so that it seems fair to suppose that the plant which they use is their own *riha* or *risa.* In none of the classic books of India is there the slightest mention of *kankúra* or *riha.* In fact there are no references to any fibre that could for a moment be supposed to be rhea. There is a curious passage, however, in the account of the *Voyage to the East Indies*, written by Linschoten (1598, i., 96), which describes a fibre under the name of " Hearbe Bengalen," that might be (and has been) supposed to be rhea, though it was more probably ***Calotropis gigantea*** floss, perhaps the grass-cloth fibre of the early English writers (see pp. 207–8). Turning now to China, Marco Polo, speaking of Kweichan, mentions the bark fibre from which " they manufacture very fine summer clothing." Many subsequent writers allude to the *hiapu* or *sia-pu* or the summer cloths of Kweichan, which being to-day made of China-grass, it is assumed were so made in Marco Polo's time ; and there is probably little doubt that they were. One of the earliest European travellers to describe the China-grass (of China) was Cunningham, who in the beginning of the 18th century sent Chinese plants to his English friends Sloan, Petiver and Plukenet. Among these was the textile plant *ma*, which he called *Urtica racemifera maxima Sinarum* (*Pluk. Amalth.*, 212, t. 49, f. 2), a plant which Linnæus identified (*Sp. Pl.*, 1764, 1398) with his ***Urtica nivea.***

Not mentioned in Indian Classics.

Ramie.

β **Var. tenacissima** (*sp Roxb.*); Watt, *l.c.* 20, t. 2. This is the true *rami* or *ramie*, which by some writers has been incorrectly called rhea while they have assigned China-grass as distinctive of the variety ***nivea.*** The first record of its introduction into India brought the Sumatran name *calúe* (*kalúc*) *caloce* or *caluse* to that country ; throughout the Malay it is *rami, rame, ramien* or *gunn* ; *inan* in Bonoa ; *gambe* in Celebes ; *moumineram* in Java ; *kiparoy, kapieriet, haramay, lalakie*, in Sunda ; *kloei* in Sokojan, etc., etc. Prain (*Sketch of Life of Francis Hamilton* (once Buchanan), 1905, 24) gives a letter of Hamilton's dated 1814, in which he refuses to believe that the *caloce* differs from ***B. nivea*** and further that he considered it groundless to expect the fibre to turn out of general use. Roxburgh (*Trans. Soc. Arts*, 1806, xxiv., 148) tells us that in 1804 the plants grown in the Botanic Gardens, Calcutta, from Malay seed had flowered and that he had sent a drawing of the same to the Court of Directors.

Uniformity of Stock.

Races of Plant Grown.—During repeated investigations, through the Indian rhea districts, a large percentage of the known plots of cultivation in Bengal, Assam and Kangra were systematically visited. With practically only one exception the stock was that indicated above as *var.* ***nivea,*** and the one exception that of a tea-planter's vegetable garden in Assam, where a few recently imported roots of *var.* ***tenacissima*** were found. In several instances, however, plants which might be regarded as local developments, if not crosses between the two varieties, were met with, thus possibly pointing to a cultivation of *tenacissima*, since abandoned, or to *tenacissima* being only a sport from *nivea*. Recently I have heard from Tirhut that a sport had spontaneously appeared there, in an experimental plantation, which was very hardy, although apparently an inferior fibre-yielder. There seems little doubt that careful study and selection would do much to improve the crop. But in no instance were plants grown in India seen to possess anything like the apparent luxuriance of a series of botanical specimens procured direct from Wenchow in China. Some of the most vigorous plants collected by me in India were found in North Lakhimpur, Assam, while the healthiest looking were those in the Ram Bagh plantation in Kangra —the survivals of the original six plants imported in 1863 by Mr. James Montgomery, India's pioneer rhea-planter. His widow, a very old lady, was alive at the time of my visit, and I had the extreme pleasure of being conducted by her over the plantation, and was much fascinated by the undying faith which she manifested in the ultimate success of her husband's life-work. One plot, she told me, had neither been transplanted nor manured for sixteen years, and yet the plants were fairly vigorous-looking. It was annually inundated and richly manured by the rise of the river. When I inquired if any of the European tea-planters in the district or Native zamindars had followed her example and laid out plots of land with rhea, Mrs. Montgomery replied that it was perhaps fortunate for her that they had long since abandoned all thought of rhea, because the produce of her little plantation was more than sufficient for the local demand.

Sports.

Vigorous Plants.

Undying Faith in Ultimate Success.

Local demand.

RHEA CULTIVATION IN INDIA.

Cultivation.

Future Prospects.—Indian Rhea cultivation and manufacture was dealt with very exhaustively in *The Agricultural Ledger* (1898, No. 15). That paper was the result of a special tour of inspection, conducted under orders of the Government of India, to each and every district where the plant was known to be cultivated or reputed to be found. With the details thus readily accessible, it may be the most useful course to make the present review amplify or correct the opinions already set forth, rather than to repeat in abstract the established facts. At the same time opportunity may be taken to answer the objections and difficulties that have been raised without becoming controversial. My previous writings have been affirmed to discourage endeavour, and as that was not my intention I would explain that my attitude has proceeded from mature conviction that a rhea industry is not likely to be established in India until certain misleading statements and misconceptions have been effectually removed. Of these I would mention the following:—

1. The affirmation repeatedly made, that rhea is a wild plant, found over large portions of India, and that it has only to be cut in order to be turned into gold. In my report of 1898 I have shown that this is not only an error but that rhea nowhere exists in India even as an escape from cultivation. That it is purely an exotic and is rapidly exterminated from land when neglected or abandoned. Still further, that the most valuable of the so-called wild-rheas (*ban-rhea*) of Assam is an entirely different plant, though one which affords a fibre for which there might be a market apart altogether from the possibility or not of organising an Indian rhea trade.

Not Indigenous to India.

2. The statement that it can be grown anywhere in India and with a purely nominal amount of cultivation and care. Far from this being so, it is a plant that requires a particular class of soil, a large supply of manure annually, and definite climatic conditions. It must thus receive high cultivation and be protected from animals. If the price paid for the produce will not suffice to cover these expenditures then the industry will not pay.

High Cultivation Essential.

3. The purport of my report may, therefore, be said to be that the experimental cultivation in India by Europeans has hitherto been in the most unlikely regions and that the price offered for the produce has rendered essential methods and

Unlikely Regions.

Low Price obtained.

Selangor Experience.

materials of cultivation prohibitive. This last statement might be compared with the final experience of Mr. Cyril E. Baxendale of Selangor. That gentleman seems to have been most unfortunate to say the least of it, for he tells us that his correspondence with "ramie spinners would fill a massive tome." He could not apparently dispose of some of his produce, and had to direct it to be burned in order to save demurrage charges at Liverpool. As a not unnatural consequence he adds, "We now leave the ramie to the cows. *They* like it." [*Cf. Capital,* Aug. 11, 1904; *Agri. Bull. Straits and Fed. Malay States*, 1903, 359, 362–6; and compare with *Ind. Gard. and Plant.*, Dec. 15, 1898.]

Climatic Influences.

The Chinese Plant.

4. I have endeavoured to point out that the most satisfactory regular cultivation and the most promising experiments seen by me, have been those within approximately the self-same latitudes as the successful production in China. In other words, the southerly extremities of Rangpur and Bogra in Eastern Bengal would be approximately in the latitude of Canton and Formosa, and the most northerly Indian area (Kangra) in that of Nanking. Thus the Indian area of successful production so far as ascertained by me corresponds fairly closely with that of China, and I have urged that in dealing with the Chinese form of the plant, at all events, it would be well in the future to concentrate attention on the region indicated. And I may add that within the more southerly limits of that area I found the plant by no means so vigorous as on the most northerly, so that a northern rather than a southern extension would seem most full of promise. Outside the area, more especially within tropical tracts, it would appear likely, however, that good results might be obtained with the Ramie or Malayan plant.

Singular Uniformity of Knowledge and Purpose.

Not a regular Agricultural Crop.

A Garden Plant.

High Manure Essential.

Conditions of Cultivation.—During my tour of inspection through the Indian rhea districts I had frequent occasion to comment on the singular uniformity that prevailed in the name given for the plant, the character of the stock grown, the location of the plots of land under the crop, the class of cultivators concerned, the method of cultivation pursued, the system of separation of fibre employed, and the purpose to which the fibre was put. These and many other points seemed significant and highly exceptional in Indian agriculture as a whole, where much diversity of opinion is usually manifested. In Bengal and Assam the plant had to be grown in order to secure fibre wherewith to make or repair fishing appliances, and there the matter began and ended. Usually the Indian agriculturist shows interest in the produce of his fields; rhea is not an agricultural crop, it is a plant grown by or for the fishermen! In only one Sub-division of the Rangpur district (Kurigaon), and even there in connection with but one or two villages, was it found as a field crop in the hands of the regular cultivators (*rajbunsis*). Everywhere else it was exclusively a garden plant found on the homesteads of the fishing classes. On an average the plots would not exceed 20 square feet in size, and were as a rule beds of pure manure sometimes 2 feet in thickness, raised above the level of the surrounding land, and closely fenced in to protect the plants from cattle which otherwise would completely devour the crop. In China it is practically grown on poudrette. A writer in *The South Indian Observer* (March 1902), who professes to have a practical knowledge of rhea-growing both in India and China, says that no part of India is in any sense a favourable field for the introduction of the rhea-planting industry. [*Cf* with the reprint in *Ind. Plant. and Gard.*, June 1902, and compare also with *Plant. Gaz.*, Dec. 1898.]

Rangpur Cultivation.

Local Price of the Fibre.

A Garden, not Field Crop.—In the whole province of Bengal it would be difficult to find a better soil or a more enlightened class of cultivators than in Rangpur, and yet few, if any, have taken to rhea, in spite of the fact that the fibre fetches locally from £50 to £180 a ton and even more fabulous prices. They have witnessed the plant being grown by the fishermen for at least a century. Buchanan-Hamilton's description of its cultivation in 1807 might be given as an account of the rhea-production of to-day, and yet the cultivators gave almost invariably one answer to the inquiry made by me why they did not take to rhea. "Why should we?" they asked. "We have other crops that pay quite as well and give infinitely less trouble." To that I had no very definite answer to offer. It would have been useless to have made the assurance that if they were prepared to risk a little, a large export might be developed and machinery invented that would perhaps render rhea-fibre production both profitable and easy. The Indian cultivator is neither willing nor able to undertake risks, still less to purchase machinery. Tobacco and ginger in Bengal and tea in Assam are consequently likely to continue to occupy the land best suited for rhea, until European capital and enterprise come to the aid of local resources. Dr. Buchanan-Hamilton drew the attention of the Indian cultivators to rhea as a valuable fibre and expressed the hope that jute (which he also found in the same districts with rhea), a fibre then quite unknown in Europe, would not attract attention until san-hemp had been given a fair trial. What has been the result of the hundred years that have come and gone? Both rhea and san-hemp are in the identical positions to-day that they were when Buchanan-Hamilton wrote; in fact if anything they have gone backward, while jute has expanded into one of the most important crops of present-day Bengal agriculture. It cannot, therefore, be said that in the region of rhea cultivation the farmers are opposed to such new crops as trade may demand, so long as they are profitable. The undoubted answer to the present state of affairs must be that jute has paid handsomely and rhea has hitherto offered no inducement to extended production.

Other Crops available

Rhea *versus* Jute.

No inducement offered.

Indian System of Cultivation.

It may perhaps be as well to bring into prominence the admission that it is impossible to furnish a definite statement of the cost of production and possible margin of profit in rhea cultivation. Though many writers have loudly condemned unfavourable opinions about the future of rhea and have given their personal assurance of ultimate success, no one has been either able or willing to furnish actual data that could be accepted as representative. It may perhaps be the more convenient course, therefore, if I arrange province by province such material as exists regarding the methods of cultivation and experience gained generally.

Bengal: Eastern and Northern.—***Soil and Rotation.***—At Joyganj, in the district of Dinajpur, the late Rajah Syama Sankar Roy, Bahadur, experimented with rhea. He laid out several plots of high land that contained a rich loamy soil and aggregated 600 acres. He placed the plantation thus formed under the charge of a European manager. The plants grew remarkably well and gave three (sometimes four) cuttings a year. The experiment had to be discontinued, however, since the price offered for the produce was not equal to actual cost of production. The land was simply abandoned, and fourteen years later (the date of my visit) not a plant of rhea was to be found, though much of the land had never subsequently been cultivated. In Rangpur district rhea is fairly extensively grown, but with one or two exceptions not as a field crop. It flourishes exclusively within the tobacco-growing portions of the district, and most successfully where the finer qualities of tobacco are produced. It demands the best soil; the land must be

Bengal.

Native Gentleman's Experiment.

Cuttings.

Failure.

Indigenous Cultivation.

Best Soil.

Tobacco *vers.* Rhea.

above height of prolonged inundation, but possessed of free subsoil moisture (which in Rangpur is about 3 feet below the surface); the fields have, moreover, to be manured and carefully tended. In Rangpur wherever soil of a rich sandy loam occurs, there *kankura* cultivation may be expected, and wherever heavy clay soils appear there it disappears. In other words, wherever a situation and soil suitable for tobacco is met with, there rhea may be found, and when grown on fields it is rotated with tobacco and ginger. Of Bogra the same remarks may be made, viz. that tobacco and rhea occur on sandy loam, rotating with chillies and sweet potatoes, but that the absence of all these is universal with the appearance of red-clay soils.

Restricted Cultivation.

Rice and Jute Land Favourable.

Physical Features.

Unusual Vegetables.

Climatic Conditions.

It is hardly necessary to repeat similar observations regarding the other districts of Northern and North-Eastern Bengal. The plant is not grown in every district, nor in all parts of the same districts where it is met with. In Dinajpur, for example, it is confined to the northern tracts; in Rangpur, Bogra, Jalpaiguri and Kuch Behar, similar isolations exist. In other words, there are conditions that seem to have arbitrarily restricted production in the past and which are admitted freely by the cultivators as favourable or unfavourable to the crop to-day. One instance may be given at once. Rhea will not grow as a field crop nor even as a profitable garden plant to the south of Bogra in the rice and jute clay lands. But much more obscure though doubtless of equal value are the botanical facts I have endeavoured to deal with in my report. The comparative absence of leguminous plants, both as wild species or as field and garden crops, is a most significant feature of the rhea country. So again importance must, I believe, be attributed to the appearance of certain peculiar garden crops, not met with outside the area in question. Of these I would specially mention—***Malva verticillata, Chrysanthemum coronarium, Brassica cuneifolia*** (a plant closely allied to Chinese cabbage) and ***Rumex vesicarius***, which, with the green tops and flowering shoots of rhea itself, are all extensively eaten as vegetables and take the place very largely of the peas and beans of other parts of India. So again ***Corchorus capsularis*** is very possibly a native of China and that plant is common in Eastern and Northern Bengal and Assam, while ***C. olitorius*** is the jute of the other districts of Bengal and of India generally. These are striking coincidences if that be the view taken of them. In my opinion they have a far higher value, and justify the conclusion that there are climatic and other physical conditions intimately associated with the restriction of the area of what might be called the Indian commercial (or rather, successful) production of rhea to the tract of country indicated—a country that might be said more closely to resemble the rhea area of China than of any part of India.

Methods of Cultivation.

Seasons.

Weeding and Hoeing. Manure.

Methods of Cultivation.—In Bengal rhea is propagated by root cuttings, though the system of burying stem-cuttings horizontally is sometimes pursued, more especially to fill up vacancies and to increase the number of plants in the field. The cuttings are usually 6 to 9 inches in length and planted under 3 to 4 inches of soil. They are placed from 1 to 3 feet apart each way. There are said to be two seasons for transplanting, the *first* in April to May (before the commencement of the rains), and the *second* in September to October (at the close of the rains). The majority of cultivators favour the former season. The fields are weeded and hoed after each cutting and heavily manured every year during the cold season. Unless so treated, and liberally, the plants should be removed into new plots of land after two, three, or at most four years, according to the fertility of the soil.

Length of Shoots.

Selected Cuttings.

Number of Cuttings.—The shoots are cut down when the bottom portion of the stem begins to turn a brown colour. At this stage the leaves, low down on the stem, also begin to fall off. Two to four or even five cuttings are obtained a year, the shoots being 4 to 5 feet in height. The majority of cultivators mention three cuttings as a good average crop. Two cuttings they regard as indicative of neglectful cultivation, and five or six, they hold, can only be obtained from very small plots, shaded, heavily manured and freely watered. As a rule the entire plot is cut down at one and the same time, but occasionally the more intelligent cultivators select the stems when ripe, and thus practically cut only small quantities at a time, but throughout the year.

Seasons.

Green Manuring.

Winter Cuttings (see below under Assam).

From September-transplanted plots the following were given as the seasons for cutting: 1st cutting in May (the worst); 2nd in June (the best); 3rd in July; and 4th in August. But many cultivators prefer to reject the May cutting and to use it for green-manuring the plot, thus having only three cuttings. If transplantation takes place in April to May, there are usually only the three cuttings already indicated. A cutting made later than August is regarded as affording a very inferior fibre. Many cultivators, nevertheless, cut down the plants once or twice during the cold season, but with a view to cause a vigorous simultaneous shooting for the June cutting.

Yield.

Jute *versus* Rhea.

Outturn.—The information procured by me on this subject was so unsatisfactory that I hesitate to publish it. So far as I can learn, the average yield of the highly cultivated homestead lands, worked out to the acre, would not exceed 600 lb. (say 5 to 7 maunds) per annum of roughly cleaned and dry fibre. As compared with this it may be stated that the average yield of jute might be put at 15 to 20 maunds. It has been urged by some writers that since it gives 2, 3 or even 4 cuttings a year, the yield of rhea is bound to be higher than the one cutting afforded by jute. But jute occupies the land for, say, only a few months, that is to say it is not a perennial but an annual crop; it can be raised on much cheaper and more abundant land than rhea; it demands little or no cultivation, and usually no manure; and lastly the fibre is easily separated. With these advantages, let alone the facts that it produces more stems to the acre and these grow to a length equal to the combined length of all the cuttings obtained from rhea, it is not to be wondered at that jute is both more popular and more profitable than rhea at the prices at present offered by Europe.

Future Expansion of Trade.

Sub-montane Tract.

Western *versus* Eastern Trend.

Probable Direction of Expansion.—The most hopeful prospect of a future Indian expansion may be said to lie within its present area in North Bengal. The overflow might then be looked for to pass east and north-east into the valley of Assam rather than to go to the southern and south-western or south-eastern districts of Bengal. In fact, it would almost appear as if there had been a migration north-east since the date of Buchanan-Hamilton's explorations in 1807. Its suitability to the Rangpur and Jalpaiguri districts and to the Duars, would point, however, to a possible expansion westward towards Tirhut. In other words, it would almost seem as if the Indian rhea of cultivation might become distributed within the belt of districts which, starting in the extreme east-north-east in Lakhimpur and passing through Sibsagar, Nowgong, Kamrup, Goalpara, Kuch Behar, Rangpur, Jalpaiguri and the northern extremity of Dinajpur, would pass still west to Purneah, Bhagalpur, Durbhanga, Muzaffarpur, Champaran, and possibly also to Saran. The sub-montane character of this tract of country, skirting as it does the foot of the Bhutan, Sikkim and Nepal Himalaya, may be at once admitted as very possibly possessing many physical and meteorological characters in common. It may be said to lie between 25° 30′ and 27° north latitude. How far a western expansion may be possible the future alone can reveal, but it may be added that recent experiments in Tirhut and those proposed in Purneah seem encouraging. No climatic difficulty would appear at all events to exist in the way of an eastern distribution. Rangpur lies right in the centre of the region indicated, but, as already stated, the crop was found to attain its greatest perfection in the north and the north-eastern divisions of that district—the portions that may be said to face eastward towards the Brahmaputra valley.

Calcutta.

By way of concluding these brief observations on the Bengal rhea industry, it may be added that Sir D. M. Hamilton, of Messrs. Mackinnon Mackenzie & Co., is believed to have prosecuted with fair success the experimental cultivation of ***Bœhmeria nivea*** for some few years in the immediate neighbourhood of Calcutta. It may, therefore, be said that the Indian people are looking to him to prove or disprove the commercial possibilities of this fibre. Capital and personal enthusiasm are the essential elements of success, and it seems, therefore, likely to be established whether Lower Bengal is or is not the most hopeful centre. And as having a direct bearing on this issue it may be added that a writer in *The Englishman* (Dec. 6, 1900), who signed himself " D. M. H.," made the pertinent observation, " Until we know the cost of growing the article it is not much use discussing the cleaning and manufacture." That is the *crux* of the whole controversy ; will it pay ?

Assam.

Assam.—It is perhaps hardly necessary to repeat all the conditions and circumstances of rhea cultivation in this province, since in most essentials these are identical with what have just been stated regarding Bengal. One or two important differences may, however, be set forth. Assam, having been a poorly populated country prior to the advent of tea, much of the fertile sandy loams that in Northern Bengal have for centuries been under crops were available for European enterprise and rapidly became tea-gardens, instead of rice, wheat, tobacco, ginger and rhea farms. Any expansion of rhea plantation in this province would, accordingly, have to contend with tea, for available waste land, and with European planters instead of Native landholders. Another feature, and one of even greater importance, may here be stated, namely that the valleys of the Brahmaputra and Surma carry culturable flat and undulating lands far to the north of the districts discussed in connection with Bengal. According to my observations this northern trend is distinctly advantageous. Moreover, Assam possesses in a remarkable degree the features of vegetation already discussed in connection with Northern and North-Eastern Bengal. As I take it, therefore, Assam is pre-eminently the rhea province of India, though doubtless to this category must be added the northern tracts of Burma, which are practically an extension eastward of the rhea area, until it becomes conterminous with that of China, Cochin-China and the Malay Peninsula. In fact it might be said that the districts of Northern and North-Eastern Bengal, discussed above, are collectively the most western section of the great Rhea, China-grass and Ramie area of the world.

Tea *versus* Rhea.

Northern Trend.

Rhea Area of the World.

Two other peculiarities of Assam may now be mentioned—one highly favourable, the other unfavourable. There is a climatic feature of the rhea area that in Assam becomes greatly developed, namely the winter rains and humidity. The cold season instead of checking growth carries it forward, so that the growing season extends almost right up to the hot season. In other parts of India the dryness of the atmosphere during the winter months is such that growth is checked at the close of the rains. The untoward aspect is that the immense natural fertility of the soil has rendered the Assam people the least industrious of all the races of India. As a rule a man need not work more than half the week in order to ensure not merely the necessities of life, but the comforts that he and his family desire. That being so, nothing in the world will induce the ordinary Assamese cultivator to do more work than he pleases. It is hopeless, accordingly, to look to the people of the country to engage in a new and arduous piece of work, however remunerative it might be. If rhea is to be established in Assam it will have to be by European capital and enterprise and through imported labour. Will this pay ? It might as a by-product with tea, but we have nothing to show that it would by itself.

Favourable Climatic Condition.

Winter Rains.

The Labour Question

European Capital and Imported Labour.

Will it Pay ?

Col. Hannay's Results. **Soil Required.** **Seasons.** **Yield *versus* Manure.** **Interruption Injurious.**

Seasons.—The pioneer investigator of rhea in India was apparently Col. S. F. Hannay. In 1850 that indefatigable agriculturist published a report of his experimental plantation, and described the Native methods and results in language that left little to discover for those who followed. He obtained 6 maunds of clean fibre, but was of opinion that a higher yield with more accurate methods might be obtained. Mr. Monahan (while Director of Land Records and Agriculture) wrote a bulletin on rhea cultivation in this province. As that paper is easily procurable, and has been largely drawn upon in my detailed report, I do not consider it desirable to reproduce it further. Briefly, it may be said that just as in Bengal so in Assam, the finest sandy loams are required for the cultivation of this plant—a circumstance that of necessity enhances the cost of production. It is usually planted out in April and May, or in October and November. After two years the soil becomes exhausted and the rhea stems weak and thin ; the roots are then taken up, divided, and replanted in a plot of land specially prepared for their reception. With frequent manuring the plant, may, however, be continuously grown on the same land for many years. Rhea planted about the end of the rainy season, say October to November, will yield a first cutting about the end of March or beginning of April, and will continue to give cuttings every month or six weeks in the rainy season and every two or three months in the cold weather. It would thus seem that in Assam four or five cuttings a year may be depended on, say in May, June, July, August and November, or even as late as December. One cultivator whom I questioned personally said that he could make his plot give cuttings every 15 or 20 days ; yield, in his opinion, was purely a question of manure and moisture. He held that the quality of the fibre depended upon the rapidity of growth ; the older the stems the coarser the fibre, and hence high manuring paid, and when moisture was deficient irrigation would also be profitable. A sudden interruption to growth, he thought, ruined the fibre. I believe upon the whole he was very nearly right, and his remarks have a special bearing on the rhea produced outside the area I have indicated, more especially in the warm dry tracts of Northern India, which have a short term of annual humidity followed by many months of extreme heat and an absolutely dry atmosphere and soil.

Yield. **Safe Average 640 lb.** **Actual Crop Experiment.**

Yield.—This has been variously stated. According to Mr. Monahan, anything between 76 lb. and 605 lb. of cleaned fibre may be obtained per acre according to the care and attention bestowed on the crop. An estimate, based on the results obtained at the Nowgong Jail, came, however, to 911 lb. Mr. (now Sir James) Buckingham, who has given the subject of rhea cultivation in Assam considerable attention, thinks that 640 lb. (8 maunds) would be a safe average. According to another experiment in Nowgong, reported on by Mr. L. J. Kershaw, the outturn was : July cutting, 48 lb. ; September, 169 lb. ; and October, 116 lb. ; three cuttings a year and a total of 333 lb. per acre. But from an actual experiment, performed by purchasing a plot of growing rhea and reaping the crop, Mr. Kershaw showed the outturn to be 900 lb. per acre, although the owner stated that his last year's experience was 600 lb. in three cuttings.

Doubtless the labour question, as already observed, is the first and foremost consideration in Assam, while in Bengal the chief difficulty may possibly be to secure suitable land for the crop.

Burma. **Identical Conditions.** **Nilgiri Nettle.**

Burma.—So little is known regarding the rhea cultivation of this province that no good would be served by reviewing in detail the information that actually exists. Mr. Copeland, Deputy Conservator of Forests, reported of Nanlan that small plots were to be found attached to several houses in all the villages on the plateau. His account of the method of cultivation, process of separating, and uses of the fibre, etc., is precisely that already narrated in connection with Bengal and Assam, except that Mr. Copeland is of opinion that the Shans would very possibly extend their cultivation *if a remunerative price were offered for the fibre.* From Maymyo was received a sample of what was spoken of as "wild-rhea," and known to the Natives as *hpetye.* This proved, like the Assam wild-*rhea,* to be an entirely different plant and not rhea at all. The Burmese so-called wild-rhea was the stinging-nettle—***Girardinia heterophylla,*** (see p. 161), which thoroughout the mountains of India

Shoemakers' Thread.

is now and again employed by the hill tribes as a source of fibre, and is best known to commerce by the name of Nilgiri Nettle. Amongst the Shans the true rhea is, however, fairly extensively grown, and under the name of *gun*. The fibre is separated by scraping off the cuticle, then breaking out the core of wood. It is twisted into thread and woven into small bags, or employed in sewing leather sandals, etc., on account of its great strength. A modern European use of rhea is the manufacture of shoemakers' thread. The Shan bags are similar to the Naga bags made of wild *riha* or ***Villebrunea integrifolia*** (see p. 164).

Panjáb.

No Native Cultivation

Special Cultivation.

Estimated Yield 972 lb.

Panjáb.—Far away to the north-west, in the mountainous district of Kangra in the Panjáb, the first European investigator (following on the path of Col. Hannay on the north-eastern frontier) was Mr. J. Montgomery, to whom reference has already been made. In pursuance of India's sporadic policy of research Montgomery was allowed to import direct from China, at a great cost and after much loss of time, six China-grass plants. A reference to Col. Hannay, in Upper Assam, would have procured not only a large supply of the self-same plant (at a comparatively nominal cost), but would have secured at the same time full details of the methods of cultivation, as also the experience gained by him. There is no local rhea cultivation in these provinces similar to that described in Bengal, Assam and Burma. I have already admitted, however, that I consider Kangra well suited for rhea cultivation, though it is by no means so favourably placed as Upper Assam or Northern Burma. It hardly seems necessary, therefore, to review Montgomery's results further than has been already briefly indicated. His plantation was an exceedingly small one, on rich, loamy soil, annually enriched by river silt. The plants grew vigorously, were remarkably healthy, and the estimate of yield framed on the results obtained from a selected number of stems (1,000) was originally 750 lb. to the acre, but five years later a fresh estimate raised the outturn to 972 lb. It has since been admitted on all hands that estimates based on a selected number of stems, or even on small plots of garden land, are utterly untrustworthy.

United Provinces.

Experiment.

Yield of Green Stems.

Expensive Cultivation.

United Provinces.—In these provinces numerous experiments have been performed, and moreover the trials of fibre-extracting machines, conducted under the auspices of the Government of India, were held at Saharanpur. According to Col. Hyde's report, the results obtained might be thus expressed: two cuttings a year were all that could be expected, though if liberally manured and watered, three might be obtained. The green stems yielded from 1½ acres came to 3½ tons, but 480 lb. of useless stems had to be rejected, reducing the produce to 7,360 lb. of stems or 3·28 tons, which yielded by Mr. Greig's machine 207 lb. of fibre. Adding the second and a possible third cutting, the annual total yield would have been considerably under 300 lb. filasse or clean fibre per acre. Sir George King, while Superintendent of the Botanical Gardens, Saharanpur, discussed in 1869 the results obtained at Dehra Dun. He very properly observed that being "on the ground all the year round, both *rabi* and *kharif* land rents must be debited against the crop, and also water rent, where irrigation is necessary. Besides this, allowance must be made for more manure than the Native cultivator usually puts on his land." But if well manured and watered, Sir George thought three cuttings might be obtained.

Number of Cuttings.

The late Mr. Gollan (then Superintendent of the Botanical Gardens) was of opinion that at Saharanpur three or even four cuttings might be secured, the second or monsoon crop being the best and yielding about one ton of green wands, stripped of leaves, per acre. He was very correct indeed when he observed that "rhea will grow, or to be precise, exist in nearly all classes of cultivable soils with a minimum of attention, but in order to make it produce long straight wands of good fibre-yielding quality, it requires a warm, humid, equable climate, a rich friable loamy soil, which if further enriched with liberal dressings of fertilising manures, such as cow and horse dung, bazár refuse, etc., so much the better." Mr. Gollan would appear to have given the total yield at, say, 2 tons green stems, yielding at 4 per cent. under 200 lb. of fibre per acre a year. But he hastened to add: "I do not look upon rhea as a crop that can be grown with profit in the United Provinces or anywhere in Upper India, at the price being offered for the ribbons." "I, therefore, take this opportunity of warning the Upper Indian planter, to make sure of his ground, by experiments on a small scale, before he largely sinks his capital in rhea cultivation."

Yield 200 lb.

South India.

South India.—It may suffice to give but one illustration of the results and experience of South India, since there is no Native industry and it is believed that all European experiments have been practically abandoned. The Glenrock Company, Ltd., laid out a plantation of 400 acres at Pandalur in South-East Wynaad, and 100 acres at Kullar, some 5 miles from Mettapollium. These were worked for five years from 1884 to 1889, and ultimately abandoned because "the fibre obtained at the price ruling, did not pay for the cost of production." In one year 8 tons of green stems were cut from a measured acre, or 128,000 stems, but that was an experimental case. Mr. Minchin shows that the range of quantity of water in the green stems is very great—namely, from 75 to 90 per cent. of the total weight, and that it depends on the humidity of the locality or of the season of production. At his plantations the ribbons were stripped both by the Death and Ellwood machines and by the Fremy system, but during the rains "great difficulty was experienced in drying the ribbons." Three good cuttings were normally obtained in the Wynaad and with irrigation as much as six, but there is always very little rain for four or five months of the year. Commenting on this feature Mr. Minchin (late Manager of the Glenrock) observes: "It may be that a more equable distribution of rain might give a fourth cutting." In another part of his report he says: "I consider that Dr. Forbes Watson's estimate of 750 lb. of ribbons per acre is the utmost that can be obtained per annum from rhea, and *that* quantity only under very high cultivation. These 750 lb. of ribbons should give after degumming about 500 lb. of clean filasse." "Unless the market is prepared to give up to £70 per ton for rhea ribbons I do not think there is any inducement to undertake the cultivation." Let it be clearly observed Mr. Minchin means ribbons, and the market quotation for these seems to be anything from £15 to £30, or a little less than half the price necessary to make rhea cultivation profitable in South India.

European Plantations.

Abandoned.

Yield.

Machinery Used.

Humidity and Rain.

Prices Realised.

Mr. Minchin's experience and opinions are likely to be admitted as the only ones with which the public have as yet been favoured, that are entitled to be accepted as something more than speculations and estimates. It will be seen that the Glenrock had to close their plantations, Did not pay Working Expenses.

and lose their capital, because a yield of 750 lb. of ribbons or 500 lb. of filasse (the so-called cleaned fibre of Bengal and Assam) would not pay working expenses. It will be for the practical planter to consider whether indications of a trustworthy nature have been adduced for Bengal and Assam in support of a higher and a more profitable yield than obtained in the Wynaad (with its abundant cheap labour), and whether that difference will make the profit.

Conclusion.

Disappointing Results.

Past Failures.

Tirhut Experiments.

Burma.

Will Rhea Pay?

Combination of Interests.

By way of bringing these observations to a close, it may be remarked in passing that the disappointing Indian results can be contrasted with Mr. Frank Birdwood's opinions (*Journ. Soc. Arts*, 1904, 401). "What remains to be proved," he says, "is, can it be grown in India, and be prepared for the market at a profit? Many questions have to be considered; chiefly cultivation. It is impossible to lay down hard and fast hypothetical rules; the planters in India are busying themselves in the matter and their experience is worth all the textbooks ever written." Naturally, but perhaps Indian planters may ask themselves how many failures and heavy losses such as those of Mr. Montgomery in the Panjáb, of the Rajah S. S. Roy in Joyganj, Bengal, and of the Glenrock Company in South India, to say nothing of Mr. Baxendale of Selangor, may be necessary to establish the conviction that India at least, more especially outside the area indicated by me, is not the most promising of rhea-growing countries. In Tirhut, recent endeavours seem to have given some promise of a possible future success, and Mr. Bernard Coventry has recently furnished full particulars of the results obtained (see the passage below, p. 157). In Assam the plant grows freely, but with exception of the Jokai experiment, cultivation has not hitherto been seriously entertained by planters. The Jokai plantation had been abandoned some time previous to the date of my personal inspection of the rhea cultivation of India, and the Company's Manager could only show me a few miserable shoots not eighteen inches high, as all that survived. I could discover no trace of Col. Hannay's experimental plot, thus once again proving that when abandoned the plant cannot hold its own against indigenous vegetation, and has, therefore, not become acclimatised even in Assam. Perhaps the most hopeful country of all, Upper Burma, remains to be commercially exploited. But the real issue, I venture to suggest, is not "Can India grow rhea?" but "Can the purchaser afford to pay a price that will leave a margin of profit to the Indian producer?" And this will meet its solution in the further question, "Can and do other countries (China more especially) produce it profitably at a lower price than India is able to do?" Hence if there is a manufacturer's side that requires expert knowledge for its full comprehension, there is also an agricultural aspect that demands careful consideration. Both issues must go hand in hand, and perhaps the most hopeful solution would be found in the owners of patent machinery and of spinning and weaving factories undertaking, for a time at least, the production of the plant and the fibre they require. This would save the disappointment of finding no market for the fibre when produced.

SEPARATION AND MANUFACTURE OF THE FIBRE.

Separation of Fibre.

As already observed, Dr. Buchanan-Hamilton has the honour of having first published an account of rhea fibre in Bengal. Of the separation of the fibre prevalent during his time, he says, "The fresh shoots are cut, and steeped in water to procure the fibres of the bark." Now, if that was the system pursued in 1807, it has since changed completely. I have only come across one or two persons who have spoken of the use of water in the separation of the fibre. Col. H. H. Stansfield, speaking of Bhagalpur, described a process of slow boiling, simmering and beating in water. To the boiler was added crude carbonate of soda (*sajji matti*), the stems being boiled in this for 1½ to 2 hours. The shoots were then taken out and beaten on a board in contact with running water. They were next returned to the boiler and simmered for another hour, then beaten again in running water till the bark and gum were entirely removed. The ribbons were then drawn through a rough carding machine to remove all adhering woody tissues. It is said that a maund of shoots could be thus easily worked per hour, and yield 2½ per cent. of fibre ready for spinning. Mr. Montgomery tells us that he had tried retting on the green and dried stems as well as on the green and dried peel, in running water and in stagnant, both cold and hot. The results were uniformly unsatisfactory. These then (with Hannay's process of steaming, shortly to be described) are the only passages with which I am familiar where a process of retting or of boiling are spoken of as having been actually tried or used in India. It has, however, been recently announced that the Algerian method of retting in sea-water has proved an unqualified success. If that be so, a great difficulty—the removal of the gum—has been once more satisfactorily overcome. Mr. D. Hooper (Curator Industrial Museum, Calcutta) performed recently an experiment with artificially prepared sea-water and reported his results. His observations have been reproduced in many Indian newspapers [*cf. Capital; Indian Planting and Gardening*, etc.], and unfavourably criticised in the *Anglo-Indian Review*. *The Madras Mail*, commenting on this reawakening of interest, observes that "hope lives eternal in the human breast, and there is no inherent reason why in this particular case hope should tell but a flattering tale."

Retting.

Boiling with Use of Carbonate of Soda.

Beaten in Running Water.

Yield 2½ per cent.

Retting Unsatisfactory.

Use of Sea-water.

Remunerative Market.—Many writers including myself have for years past urged, however, that it is not a machine nor a process that is wanted, but a remunerative market. The Chinese method is perhaps as nearly perfect as attainable with the people and the conditions concerned. It is unapproached by any European invention or Indian indigenous process [*cf.* Letter in *South Ind. Observ.*, March 1902]. Moreover the Chinese production is on a large scale which leaves apparently a sufficient margin to meet present European demands.

Market.

Chinese Method.

As witnessed by me in Bengal and Assam the fibre is obtained purely and simply by hand scraping. *Ribbons are never prepared* by the Natives, since the bark is removed before the fibre is stripped from the twigs. The following passage from my original report gives an account applicable, I believe, to the whole of Assam and Bengal at the present day:—"The stems are required to go through a process of drying, hence rainy weather or even cloudy days during the drying stage are supposed to injure the fibre. The shoots are at once stripped of their leaves, and the leaves are very generally returned to the field as manure. The shoots are then carried to the dwellings of the cultivators, and by means of a bamboo knife or scraper are deprived of the bark and the green succulent outer-tissue around the fibre. It is regarded as essential that all the plants should be scraped or decorticated within 24 hours after being cut. The stalks are then laid out on the ground in some dry situation and exposed to the sun during day and removed within doors at night to avoid the dews, and this method of drying is continued for some 4 to 10 days. The stems are thus com-

Ribbons never prepared.

Separation of Fibre.

Stems scraped.

Drying the Stems.

Cleaning the Fibre.

pletely dried and the adhering fibre more or less bleached. They are then each broken across, a little below the middle. The finger or scraper is inserted underneath and run upwards and downwards until the whole of the fibre is removed. For this purpose the central stem may have to be broken more than once. This stripping stage is considered the most troublesome of all. After being removed from the stem, the fibre is drawn rapidly once or twice between the scraper and the flat surface of the forefinger, in order to free it from any adhering particles of the stem or bark. The after cleaning of the fibre, preparatory to its being spun into thread, is done for the most part by the women and children, and consists entirely in splitting up the cords by means of the fingers. Sometimes, however, it is dipped for a few minutes into a boiling solution of *haldi* (turmeric), from the idea that it is thereby softened and rendered more easily separable into its finest bands of fibre. In one instance, while in Bogra, I was told that the partially cleaned fibre was boiled for a very short time in the water obtained after cooking rice. This was also said to soften the fibre. It is probable that both with *haldi* and rice-water the advantage secured might have been obtained through boiling in water only, but it is perhaps desirable that this question should be chemically investigated."

Fibre Softened by Boiling in Rice-water.

Preparation of Fibre.

Ribbons.—It is customary to find (in reports published in Europe) the statement that rhea ribbons are exported from India. I cannot say definitely that that is not so, but I should think it highly probable that the supply must have been derived exclusively from European experimental plantations (the Glenrock, for example) or that it was prepared to order. The Bengal cultivator invariably scrapes off the bark before separating the fibre from the stem, and thus offers for sale what may be a crudely cleaned fibre (or China-grass) but is certainly not the much condemned "Indian rhea ribbons" that have given an evil name to, and greatly lowered the value of, the Indian fibre. The Bengal cultivator, strictly speaking, decorticates first, then strips the fibre, and it seems to me his process is a more rational one than that followed by each and every one of the inventors of the so-called decorticating machines hitherto placed on the market. These either strip off the bark with its adhering fibre or smash up the contained stem (scutching) and liberate the bark and fibre in that way. No doubt by a subsequent action some of them get rid very largely of the adhering bark, but they fall far short of the operation of complete removal of the bark and of the green pulpy external tissue which is immediately effected by the cultivator on the stems being cut. Whether his subsequent process of drying the exposed fibre before separating it from the stem is advantageous or not I have had no opportunity of testing, but long acquaintance with the Indian cultivator has prejudiced me in favour of the view that he rarely does much within his own sphere of life that is useless, and he certainly never imposes on himself very considerable additional labour to no purpose.

Decortication before Stripping.

Decorticating Machine.

Chinese Ribbons.

According to the description given by Col. Hannay in 1850, the Chinese strip the bark and fibre into ribbons as the first operation. The ribbons are then steeped in water for a couple of hours, and thereafter scraped to remove the bark and gum. He then adds that this is quite different from the method pursued by the Dooms in Assam, and observes, "A cheaper method of preparation, and one which is best suited for separation on a large scale, is to subject the strips of fibre, after being taken from the stalks, to the steaming process in boxes, tubes or cylinders. The steaming will soon carry off the sap and its bad qualities, and the bundles well dried will then, I think, be quite in a marketable state." Here we have what may be regarded as the principle, if not also the actual manipulation, of the process patented many years afterwards as the Fremy system. Speaking of the Wynaad experiments, Mr. Minchin says, "Small portable boilers on wheels were used, which followed the coolies who were cutting the stems along roads through the cultivation. The steam was turned into closed wooden boxes into which the stems were placed. The skinning by hand was a slow process, but the ribbon was saved."

Steaming Process.

Fremy System.

Various Operations.

Machinery and Processes.—So much has been written for and against the various machines and processes that have been invented and patented for stripping the bark into ribbons, for degumming the fibre, or for producing filasse direct from the stems, either by chemical or mechanical contrivances, etc., etc., that it seems undesirable to venture further, in this very brief sketch of the existing Indian rhea industry, on so very controversial a subject, and one which has hardly assumed practical importance in India. It may, however, be said that by one set of writers it has been upheld that the proper way is to treat

Green Filasse.

Ribbons or Dry Stems.

Finally Cleaned Fibre.

the green stems and produce direct what might be called a green filasse; by others, that since the fibre from such a process has still to undergo an elaborate chemical treatment before being fit for the spinner, there is nothing gained by turning out filasse on the spot. All that is required is the production of dry ribbons or even dry stems. By still another set of writers it has been upheld that the percentage of fibre to bark varies so very greatly that it would be dangerous to organise a future trade on such a basis. The prices offered for ribbons of bark would have to be very low, in order to safeguard against an unprofitable yield of fibre—thus ruinous to the grower of good stock. It has accordingly been contended that success can alone be obtained if the clean fibre, in a state very nearly, if not altogether, fit for the spinner, be produced by the grower, though perhaps at central factories adjacent to the areas of cultivation.

In the *Kew Bulletin* (add. ser., ii., 1898), the reader will find full particulars regarding the various methods of cleaning the fibre, and of all the machinery up to then in use.

Tirhut Experience.

Bengal Rhea Syndicate.

Faure Machine.

Yield.

Rough Decortication.

Mr. Bernard Coventry's highly interesting paper in *The Agricultural Journal of India* (1907, ii., pt. i., 1–14) reached my hands after the above observations had been passed to the press. It has thus been only possible for me to make room for a brief notice. He would seem to lay more stress on the machinery used than on the climatic and soil conditions of the countries of production or the race of plant grown. In that he may possibly in the future find himself mistaken. In any case the yield of 2½ per cent. of clean fibre is practically that mentioned by not a few of the past Indian investigators, from Hannay, Stansfield, etc., downwards. But Mr. Coventry narrates the circumstances under which rhea fibre cultivation had been undertaken in Tirhut. These, it would seem, were precisely those recommended by me some years ago (*Agri. Ledg.*, 1898, No. 15, 466-7). And briefly as follows:—A company of Calcutta merchants (the Bengal Rhea Syndicate, Ltd.) undertook to supply the Faure machines for the decortication of the plant, and to ship and sell the produce. Certain Indigo plantations were to grow the plant and prepare the fibre, "the expenses and realisations in connection with the whole enterprise being brought under a joint account." "The area covered by these contracts aggregated over 3,000 acres. As the planting and cultivation progressed it was found, however, that many localities which had been selected were unsuited to the growth of rhea, so that ultimately the area actually put down did not exceed 2,000 acres" (Coventry, *l.c.* 4). In a further passage Coventry mentions incidentally the area in Dalsing Sarai as having been 500 acres. Speaking of the subject of yield, he says, "The stems in well-established plants should be as tall as possible, from 4 to 6 feet, but never less than 3 feet. Four good cuttings should be secured per annum if it is to pay, and the total weight of these four cuttings of green stems should not be less than 30,000 lb. per acre, or say 15 tons. The yield of dry fibre from these stems should not be less than 2½ per cent., making 750 lb. per acre per annum. This amount will vary with the efficiency of the decorticating machine. The possible amount of fibre to be obtained from the stems is believed to be 5 per cent., but owing to the large amount which is broken and cut away in the rough process of decortication, only 2½ per cent. can be relied on for an average yield with existing machinery, and this is given by the Faure machine." It is thus not quite clear whether these are the results actually obtained at the Research Institute, Pusa, or only indicate Coventry's personal opinions and expectations. It is all the more disappointing, therefore, that this uncertainty has to be concluded by the opinion that "if the spinners are truly desirous of developing this important industry they must encourage the growers and offer a price more commensurate with the intrinsic value of the product." What is doubtless wanted is a remunerative demand. [*Cf. Agri. Ledg.*, 1898, No. 15, 466; *Kew Bull.*, 1907, 4-8.]

Use of Fibre.

Markets where Fibre may be purchased.

Indian Industrial Uses.—I came across no Natives of India who were aware that the fibre could be spun into such fine yarn that it might be woven into fabrics. In the case of Bhagalpur it is stated that it had been used some twenty years ago in admixture with silk. Whether it is still so employed I have been unable to discover, but throughout Bengal and Assam it is spun into coarse thread, three strands of which are again spun together to make fishing-lines and the cord of which the *kai jalas* or fishing-nets are made. While travelling in Dinajpur and Rangpur I heard of one or two markets or annual fairs at which the fibre, the cord, or the nets of rhea were said to be regularly offered for sale, such as the Bora Daróga *mela* and fair at Kaunia.

FINANCIAL ASPECTS OF RHEA.

Yield and Prices.

Returns from Other Countries.

Perak Yield 1,173 lb. of Fibre.

Wenchow Results.

Yield in Other Countries.—The foregoing remarks have been thrown together with a view to represent all that is actually known regarding the cultivation and manufacture of rhea in India. I have quoted figures of yield and prices obtained for bark and fibre, but I have not attempted to give actual estimates of the cost of production nor of the practical results obtained, because so far as I am aware these can hardly be said to exist in connection with India. It would seem, however (to judge by the yield of bark and of fibre reported from other parts of the world, where rhea cultivation has been conducted on business lines), that we have to suppose that the plant is infinitely less productive in India; in other words, that India is not well suited for rhea production; or that the plant has degenerated to a stock very much inferior to that which exists in China, Japan, the Malaya, and America; or that our system of cultivation is altogether defective and deficient: or that the Indian results have been much under-stated; or, lastly, that the returns from other parts of the world have been greatly over-stated. I cannot, therefore, attempt more than to allude briefly to some of the figures that have been published outside the limits of India. In a report issued by Mr. L. Wray, jun., the results of the Perak Government cultivation are given for five experiments. These varied in yield from 1,280 lb. to 2,508 lb. of ribbons per acre, or a mean of 1,656 lb., which gave 1,173 lb. of cleaned fibre. With so splendid a result (very nearly double the usual figures recorded for India) one would have expected the experiment to have been announced as a financial success, but Mr. Wray tells us that with ribbons at £7 a ton in London, a net loss of $18.30 per acre was sustained. Of Wenchow in China it has been found that one cutting of 80,000 stems yielded 312½ lb. of fibre per acre. It is thus possible that, adding the other cuttings, the total return would have been 900 to 1,000 lb. of China-grass.

Singapore.

Malay, 1,680 l

Californian Yield, 1,935 lb.

Mr. E. Mathieu of Singapore has published a highly satisfactory account of rhea cultivation in the form of a review of the results obtained by the Director of the Botanic Gardens of Java. Mr. Mathieu supports his views by reference to parallel results obtained in America and Algeria. He believes that after three or four years' growth a Malayan plantation should yield in four cuttings 20 tons of stems per acre, and that these ought to give 3·75 per cent. of clean dry fibre or 1,680 lb. per acre, worth in London £24 a ton, which would yield a net profit over working expenses of $102.30 per acre. If this estimate be accepted, the Malay plantations would yield fully double the average outturn mentioned in connection with India. But even such a splendid production falls far short of others that have to be recorded. According to certain returns published in connection with the Keru valley, California, four cuttings are said to have been obtained a year, making a total of 50,400 lb. of green stems, or a little more than double Mr. Mathieu's estimate for Malayan production and perhaps five times the mean of all the figures given above in connection with Indian experience. Mr. Charles Richard Dodge (*Useful Fibre Plants of the World*, 89) gives 25 tons of green stems with leaves as a fair average for California, and Hilgard mentions a yield at the Californian Experimental Station (*Bull.*, Nos. 90, 91) of 1,935 lb. of fibre per acre. From the experimental cultivation of a small plot of ***B. nivea*** at Kew, it was calculated

Algerian Yield, 1,280 lb.

that the yield would be 29,000 lb. (say 13 tons) of green stems after the leaves had been removed. At Algiers (according to the late Director of the Botanical Gardens—Mr. Hardy) the yield was 48,000 lb. of green stems with their leaves, or 27,600 lb. of stems : this amount on drying is reduced to 4,900 lb. and affords 1,400 lb. of fibrous thongs. But two such crops may be obtained a year, so that the total of ribbons would be 2,800 lb. At Padua, according to M. Goncet de Mas, 26,300 lb. per acre were obtained in the second year, and 32,360 lb. per acre of stems without leaves in the third year of the plantation. The last quotation worked out at 1,280 lb. of raw fibre. Lastly, M. Favier gives 1,285 lb. of fibre per acre as the approximate average annual yield.

Uses of China-grass.

Textiles.

Chinese Paper.

Objections to Rhea.

Special Machinery.

Cost of Production.

European Industrial Uses.—I do not attempt to express a definite opinion on this aspect of the rhea question, though essentially necessary to any full comprehension of the financial issues of production in which India is at present concerned. The fibre would appear to be used for sacking, sailcloth, belting, table-cloths, sheeting, shirting, dress cloths, laces, nets, thread, string, cordage, ropes, fishing-lines and paper. Wiesner (*Denkschr. Akad. Wiss. Wien. Math.-Nat.*, 1902, lxxii., 7, 22, 28) makes many references to the Chinese use of this fibre in the manufacture of paper. On the authority of Karabacek (*Das Arabische Papier*, 28-9) he states, for example, that it was used in ancient times in China for the production of the best document papers. But the applications of rhea are more varied and diversified than those of almost any other known fibre. Still, its progress in popular favour has been remarkably slow. It is employed at present very largely for giving strength to other textiles, and has hardly assumed an independent or recognised position of its own. It might be said that its disadvantages are its abnormal strength and lasting properties under all vicissitudes ; its stiffness and glossiness ; its want of rustle ; its peculiar lustre (which has not caught popular fancy) ; and its imperfections in dyeing (especially black shades)—these are the sort of objections often urged against rhea. But it seems possible that they would all disappear if two further adverse circumstances could be overcome, viz., *first* the necessity for special and expensive machinery, and *second* the very high cost of production. The difficulty that long obstructed rhea, namely the discovery of a good decorticating and degumming machine or process may, however, be said to have disappeared, and the chief objection now advanced by the growers is that the price offered is not remunerative, and by the manufacturers that more cannot be paid until a special position has been secured for the fibre in the markets of the world.

In *The Agricultural Ledger* (1898, No. 15) are given 3½ pages of references to reports, books, newspapers, etc., in which information regarding Rhea will be found. [Many of the additional sources of information consulted while writing the present article have already been cited, but the following enumeration in sequence of dates may be added:—Schulte im Hofe, *Die Ramiefaser*, 1898 ; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 293 ; *Times of Ind.*, Jan. 7, 1899 ; *Ramie, Straits Settl.*, in *Ind. Text. Journ.*, April 1900 ; *Ramie*, in *Proc. Inter. Cong.*, June 28–30, Oct. 1–11, 1900 ; Schanz, *Die Boehmeriakultur, China*, in *Der Tropenpflanzer*, 1901, v., 126–36 ; Jumelle, *Les Cult. Colon.* (*Indust.*), 1901, 27 ; Greshoff, *Ramie, Dutch. E. Ind.*, in *Indische Mercuur*, Jan. 6, 1903 ; Van Maanem, *La Cult. de la Ramie*, in *Rev. des Cult. Colon.*, 1903, xiii. 82 ; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 319 ; Birdwood, *Anglo-Ind. Rev.*, Jan. and Feb. 1903 ; *Pioneer*, Feb. and Aug. 1903 ; Van Maanem, *Ramie and Ramie-Union*, in *Indische Mercuur*, April 19, 1904 ; Edwards-Radclyffe, *series of articles in Ind. Plant. Gaz.*, concl., June 11, 1904 ; Barraclough in *Capital*, April 21, 1904 ; Carpenter in *Trop. Agrist.*, May, 1904; *Ind. Text. Journ.*, Jan. and Feb., etc , 1904.]

BŒHMERIA OR RHEA SUBSTITUTES.

Stinging Nettles.

Practically every fibre obtained from the Natural Order URTICACEÆ or the Nettles might be mentioned as a possible RHEA SUBSTITUTE. These are, however, referred by botanists to two sub-tribes, viz. the *STINGING* and the *STINGLESS NETTLES*. Of the former may be mentioned ***Girardinia***, ***Laportea*** and ***Urtica***, and of the latter ***Bœhmeria***, ***Debregeasia***, ***Maoutia***, ***Sarcochlamys*** and ***Villebrunea***. These and a few other allied genera are well known to afford strong and beautiful fibres. There is, however, an objection to the former group that applies in nearly equal force to all the species, namely that the poison of the stinging hairs renders it difficult to collect the plants; and indeed in some instances the poison is absorbed and retained by the fibre during the process of preparation. The stinging nettles are consequently an intractable group of plants, no single member of which has assumed or seems likely to assume commercial importance in the modern commerce of any part of the world, even although the fibres they afford are strong and exceedingly beautiful. The other group —the stingless nettles—in addition to the China-grass or Rhea contains several plants that are much appreciated in the countries where met with plentifully, and mainly as sources of useful fibre. Several of these are also capable of extended utilisation, should the necessities of commerce call for new and diversified fibres. Each possesses special features of its own, and the chief difficulty that stands in their way is that which has retarded rhea itself, namely that the necessity for their recognition has scarcely arisen. By far the most promising fibre of this series is ***Villebrunea integrifolia***.

Stingless Nettles.

In the remarks that follow I shall deal as briefly as may be possible with each of the more hopeful rhea substitutes, and, as customary, in the alphabetical sequence of their scientific names :—

D.E.P., iii., 52-4.
Himalayan Shrub.

Debregeasia hypoleuca, *Wedd.*—This large shrub is met with plentifully on the margins of fields, by roadsides and watercourses, and near houses, in the western temperate Himalaya, at altitudes of 3,000 to 6,000 feet. It is best known by the following vernacular names :— *púruni*, *tashiári* (*tushiyara*), *siáru*, *tashári-siár*, *siháru*, *sandári*, *sansárú*, *amrer*, *thaná*, *píncho*, *prín*, etc.

Pollarded.

It is freely pollarded in October, and forms long, straight, willow-like shoots which yield a fair percentage of bark-fibre; the shoots are also made into crude baskets for local use. The fibre is very generally extracted by the hill people and employed for ropes and cordage. Various methods of separating and cleaning the fibre have been reported. Baden-Powell observes that the shoots are not steeped in water but are dried, and when brittle are beaten and the fibre collected. The fibre is reported to be exceptionally strong and of special value for fishing-nets, because of its resisting the action of water. As cordage and rope it is employed for all agricultural and domestic purposes by the hill people, but I have never heard of its being spun and woven nor have I come across any account of a systematic production or even of a scientific investigation of the fibre.

Dry Extraction.

D.E.P., iii., 54.
South Indian Shrub.

The closely allied species ***D. velutina***, *Gaud.*, perhaps hardly deserves to be treated as distinct. It is a tall shrub of the sub-tropical Himalaya (especially Eastern) and of the mountains of Western and Southern India and Burma—common in evergreen forests. The following are its better-known names :— *Tashiári*, *kamhyem*, *kapsi*, *kurgul* and *putchaw*. It takes the place very largely, in the mountains of Western and Southern India, of the previous species on the Himalaya. It is also used by the Himalayan people, more especially on the eastern extremity, but is less plentiful to the west than the former. In the *Madras Manual of Administration* it is spoken of as one of the chief fibres of that Presidency. It is fairly extensively used in the Nilgiri hills, and a consignment was sent to Europe by the Glenrock Company which was valued at £70

Important Fibre.

a ton! Mr. Cameron refers to it as one of the commonest and most conspicuous plants of the Wynaad and Nilgiri hills. Its fibre he tells us is used for bow-strings, and "would appear to require to be better known to be much appreciated." In Ceylon it is used for cordage and string especially suitable for fishing-lines.

Bow-strings.

Girardinia heterophylla, *Dcne.*—In commerce this is known as NILGIRI NETTLE. There are three fairly well recognised varieties, viz. (*a*) *heterophylla* proper, the condition met with on the temperate and sub-tropical Himalaya from Marri eastward to Nepal, Sikkim, Bhutan, Assam and Burma; (β) *palmata,* the special form on the Nilgiri hills and Ceylon; and (γ) *zeylanica,* the variety met with on the mountains of Rajputana, Central India, the Central Provinces, and the Deccan, south to Travancore. It is commonly stated that *palmata* yields a fibre superior to either of the others. It would be more correct to say that *palmata* had been systematically studied and reported on in 1862 by the late Mr. McIvor, Superintendent of the Horticultural Gardens, Ootacamund, while the other forms, though known to be fairly extensively used by the hill tribes, had not been separately investigated. Under these circumstances it seems likely to serve the purpose of the present work if all three be treated conjointly. The following are the vernacular names best known:—*bichúa, allú, awa, bhábar, keri, sanoli, horú-surat, pha-pat, tukak, serpa, herpa, ullo, kazu, shish-una, kubra, jurkandálú, kundálú, moti khajati* (or *moti-kajoti*), *agia, agarra, awah, ana, schorigenain, hpetye, betya, bekshá,* etc. [*Cf. Agri. Ledg.*, 1898, 78-9.]

D.E.P., iii., 498-502.
Nilgiri Nettle.

Special Investigation.

Vernacular Names.

Production.—In the North-West Himalaya *Girardinia* takes the place of *Debregeasia* in the higher and more interior or northern tracts; it occurs between 4,000 and 7,000 feet in altitude, and thus practically above the altitude of *Debregeasia.* It is a tall, stout, much-branched plant that grows to a height of 6 to 10 feet and usually in the form of dense clumps which, owing to the very poisonous nature of the stinging hairs, are left severely alone both by men and animals. The plant is, however, fairly extensively utilised by the hill tribes, especially on the Himalaya, as a source of strong and durable fibre. The long straight shoots are cut down in the cold season (August to October), stripped of their leaves and buds at once, so as to remove as far as possible the stinging bristles; they are then washed for three or four days in water, and the fibrous bark thereafter drawn off as with hemp. Capt. Rainey, speaking of the present plant, not *Debregeasia,* says the shoots after being cut are exposed to the open air for one night; then stripped of their leaves and sun-dried; next placed in vessels and boiled with wood-ashes for twenty-four hours. The fibre is thus found to separate easily and is removed, washed and sprinkled with the flour of the grain *kodra,* and left to dry, when it is ready to be spun. Campbell observes that in Nepal this fibre is used in making an exceptionally strong cloth called *bangra* (*Agri. and Rural Econ. Nepal*), and Gamble and others use for that cloth (as met with in Sikkim) the name *gunny* or *gunnia*; in Burma rhea is called *gun.* These names are doubtless derived from *bhanga* (which signifies to break) and *ganja*—two words that, at the present time, are restricted to the intoxicating property of hemp. The term *gunny* in modern commerce is applied to a sacking made of jute.

Himalayan Supply.

Season of Cutting.

Boiled with Wood-ashes.

Cloth made of the Fibre.

Origin of Name *Gunny.*

It has already been mentioned that McIvor cultivated the form *palmata* on the Nilgiri hills. The soil best suited he describes as alluvial deposits such as are found in ravines. He sowed the plant in rows 15 inches apart and cut down the young shoots for fibre twice a year, namely in July and January. In doing so he left 6 inches of stem as the stool for future shoots. After each cutting the earth between the rows was dug to a depth of 8 inches and manure applied. From the crop of July an average produce of 450 to 500 lb. of clean fibre may be expected. Of this 120 lb. will be superior quality, in other words the produce of the very young and tender shoots, which should be assorted by themselves at the time of cutting. The January crop will yield on an average 600 to 700 lb. per acre. This fibre is, however, inferior owing to the shoots being mature. Were fine fibre only desired, McIvor was of opinion it would

Nilgiri Experiment.

Method of Cultivation.

Yield.

be necessary to reap the shoots at an earlier time, and perhaps more frequently than stated.

Finest Quality.

The inner bark abounds in fibre, that of the young shoots being the finest and strongest and peculiarly silky and at the same time woolly. The shoots when cut were allowed in McIvor's experiment to remain as they fell for two or three days, by which time they had largely lost their stinging property but were pliable enough to allow the bark being peeled off and separated from the leaves. The bark was then tied in small bundles and dried in the sun. When quite dry the ribbons were beaten with a wooden mallet, which caused the outer bark to fall off and leave the fibre comparatively clean. The fibrous part was then wrapped up in small bundles and boiled for about an hour in water with wood-ashes. The fibre was thus removed and washed as rapidly as possible in clear running water, after which it was bleached as with flax or hemp.

Preparation of Fibre.

Nothing further is known of the above experiment, but it may be inferred that the result was not considered a financial success since the endeavour to grow the plant and sell the fibre appears never to have been repeated in any part of India.

Burma.

By way of concluding it may be said that, in connection with the inquiry into rhea fibre in Burma, information was received of what was called Wild-rhea—a plant fairly extensively used as a source of fibre by the Shans. On a botanical specimen being furnished this was found to be ***Girardinia heterophylla***, called by the Shans *hpetye*. Mr. Carr, Deputy Conservator of Forests, Mandalay, wrote that the fibre was not considered so good as *gun* (rhea) and was not used much by the Burmans. The Palungs, however, were said to mix it with *gun*. It is somewhat curious that the Jabako and Angami Nagas also employ ***Girardinia*** fibre mixed with their *ban-riha* (***Villebrunea***) or with cotton, and in Europe the opinion formerly prevailed that the special feature of Nilgiri Nettle fibre was the ease with which it could be mixed with wool, a property not possessed by rhea, and due to the woolly nature of ***Girardinia***.

Mixed with Wool or Cotton

Properties.—Recently, however, as a consequence of inquiries made at the Industrial Museum, Calcutta, a sample of the fibre was sent to the Imperial Institute for report. Dunstan furnished a reply which has been issued by the Reporter on Economic Products as a *Commercial Circular* (1905, No. 1). The following abstract may be here given :—

Special Feature of Interest.

It is evident that these results confirm those of Cross and Bevan, but indicate that the present sample is less susceptible to the prolonged action of alkali (as shown by the *b*-hydrolysis) and contains a larger percentage of cellulose. The fibre of ***Girardinia heterophylla*** is remarkable for its ability to withstand the action of alkali, its richness in cellulose, and the length of its ultimate fibre. There can be no doubt that the product is of excellent quality, and it seems highly probable that, if it could be prepared on a commercial scale, it might take a high position among textile fibres.

Mr. B. J. Rose, of the Indian Trade Enquiry Office, 73, Basinghall Street, London, E.C., obtained a commercial valuation of the fibre which was as follows :—

Flax Substitut

"The small sample of the prepared fibre of the Nilgiri Nettle (***Girardinia heterophylla***) received from the Reporter on Economic Products was submitted to a fibre broker, who reports as follows :—'We have examined the sample of vegetable fibre, and beg to report on same : microscopical examination reveals similar structure to flax, appearing, however, to be ineffectively retted ; soft and more open than flax, also of a more downy nature. Length and fineness similar to flax and slightly more silky. In our opinion this fibre is more likely to be employed under similar conditions to the flax fibre than as a wool substitute. We value the fibre at £20 per ton.' " [See also p. 151.]

D.E.P., iv., 587. Devil Nettle.

Laportea crenulata, *Gaud.* ; the FEVER or DEVIL NETTLE. An evergreen shrub met with in the tropical Himalaya from Sikkim eastward to Assam, Burma, Ceylon, Perak, Java, etc. Is known by the following :—*Surat*, *chorpatta*, *moringi*, *sir-nat*, *mealumma*, *pheytakyee*, etc.

Most Poisonous of Nettles.

This curious plant may be described as the most poisonous of all the nettles of India, although compared with the preceding it is harmless looking. Its stinging hairs cause excessive burning pains, which last for days, augmented on the part being washed ; at the same time it produces violent sneezing and copious running at the nose and contraction of the jaw with severe swelling of the part affected. J. D. Hooker (*Him. Journ.*, 1852, ii., 188); Masters (*Prod. Angami*

Hills); Beddome (*Fl. Sylv.*, ii., 306), and many other writers allude to the poisonous property of this plant.

Properties.—The bark is known to yield a strong and fairly useful fibre, the ultimate cells of which measure 8–16 mm., but its great loss on hydrolysis, together with its poisonous property, stamp it as unlikely ever to become of commercial importance. The Indian plant is closely allied to ***L. canadensis,*** the fibre of which at one time was of importance in Europe and which recently has been proposed for cultivation in France as a substitute for rhea.

Maoutia Puya, *Wedd.*; *Agri. Ledg.*, 1898, No. 15, 120–6, and pl. Is known as *pua*-hemp, and Nepal Hemp, and by some writers as Wild-rhea, *poi, pua, puya, yenki, kyinki or kienki, puttanti, sat-sa* or *sat-sha* or *sap-sha*, etc. A shrub from 2 to 6 or even 8 feet in height, fairly plentiful in the damp forests at the foot of the Himalaya from Garhwal eastwards through Nepal and Sikkim to the Khasia hills and the mountains of Burma, at altitudes of from 1,000 to 4,000 feet.

D.E.P.,
v., 177–80.
Pua Hemp.

Sikkim
Wild-rhea.

This is purely a wild plant and is nowhere cultivated. It does not grow in the forests but frequents glades and open places, overrunning abandoned fields. It sheds its leaves in winter, comes into fresh foliage about May, and flowers and fruits in August and September; the shoots intended for fibre must be cut before the fruit matures.

Properties.—Mr. G. A. Gammie described (in 1890) the preparation of the fibre at Mungpoo in Darjeeling, his description coinciding in almost every particular with Dr. Campbell's account written in 1847: "The bark is peeled off the stems in long strips; boiled in water, thickened with common wood-ashes until it is pulpy; then as much as possible of the adhering bark is separated from the fibre by alternately beating with a wooden mallet and washing in cold water. After this the water is rinsed out, and each bundle of fibre is thickly covered with a paste of micaceous clay, and dried. When thoroughly dry, the clay and the remaining bark are easily shaken off, leaving the fibre in a state fit for use. If fibre is required free from dust, it is repeatedly rinsed until the water runs clear, and then re-dried. The white or bluish-white clay found here and there, near streams, is preferred as it gives the fibre a good colour. If its appearance is of no consequence, yellow clay is said to be as effective. I do not know whether the action of the clay is altogether mechanical or not. A few samples which were prepared by treatment with lime and chalk were coarse in appearance and rough to the touch; those treated by clay, on the other hand, were soft and silky." It need only be added that Gammie says "*pua* is chiefly used for fishing nets and lines. I am told that formerly the Lepchas made cloth from it, but the contraction and expansion readily caused in it by atmospheric changes made it uncomfortable and undesirable for wearing apparel."

Ribbons of
Bark boiled in
Wood-ashes.

Clayed.

Use of Lime.

Sarcochlamys pulcherrima, *Gaud.*—A large shrub in Assam, the Khasia hills, Sylhet, Chittagong and Burma, and distributed to Sumatra. It bears the following names:—*golab jam, dogal* or *dággál, sonaful, tsatya, shap-sha-pen.*

D.E.P.,
vi., pt. ii.,
476.
Daggal
Fibre.

This bark gives a good rope fibre, and the leaves and twigs in conjunction with the bark of ***Albizzia*** are used in Assam in the production of a madder-brown dye.

Urtica dioica, *Linn.*, also **U. parviflora,** *Roxb.*—One or both of these plants are met with plentifully near human dwellings on the Himalaya (up to 12,000 feet) from Kashmir eastward to Assam and Burma; also on the mountains of Central, Western and Southern India, at altitudes of from 3,000 to 5,000 feet. They are given the same names as ***Girardinia.***

D.E.P.,
vi., pt. iv.,
215–6.
Common
Nettle.

Properties.—The young tops and the hypertrophied shoots (caused through the parasitic action of an aecidial fungus) are largely eaten on the Himalaya. Nettle fibre was the textile of certain purposes in primitive Europe (Hehn), and still is in use. The word Net is derived from the same root as Nettle. A knowledge of their fibres prevails in India, but it can hardly be said they are manufactured. Gubbins doubtless was alluding to ***Urtica parviflora*** when he said that the

Edible Parts.

Fibre.

plant is cut in October and sun-dried; when brittle it is beaten and the fibre separated. "Seeing it stated that there was considerable labour required in cleaning the fibre, I made particular inquiries on this head; as far as I could learn, there is no greater trouble in cleaning the fibre of the ***Urtica***, when merely dried, than is experienced with the hemp of the hills which is not retted in water." The fibre is said to be employed for making ropes. [*Cf.* Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 88-9.]

D.E.P., vi., pt. iv., 239-43.
Risa or Wild-rhea of Assam.

Villebrunea integrifolia, *Gaud.*; *Agri. Ledg.*, 1898, No. 15, 108-19, and pl.; RISA FIBRE. This small tree or bush is met with on the Eastern Himalaya to Assam, the Khasia hills, Sylhet, Manipur, Chittagong, and right across to the other side of India; on the Deccan Peninsula from the Konkan southwards;and lastly in the Andaman Islands. It is the *bon* (wild) *riha* of Assam, also *ritza*, *risa* or *ree*, *jutta*, *bon-kotkora*, *lúkoi* or *lúkoikhun*, *lipic* or *lípiah*, *kaphitki*.

Mesakhi Fibre. Deccan. Bombay Wild-rhea

History.—It affords both the red and the white fibre made known by Hannay in 1850 under the name of *mesakhi*. In fact Dalton affirmed years ago that Hannay's *mesakhi* was the same as his *bon riha*. Royle suspected Dalton to be correct and I have little or no hesitation in saying that he was so, though it is curious that none of my correspondents in Assam or on the eastern frontier anywhere have sent me either the plant or the fibre under the name *mesakhi*, nor was that name mentioned to me during any of my numerous explorations on the Assam frontier. Although fairly plentiful in the Deccan it does not seem to have a vernacular name, nor apparently is it known to afford a useful fibre by the people of Western India. During a brief tour in Coorg and the Wynaad some short time ago I personally endeavoured to learn something about this plant. It was found plentiful in the lower damp valleys near the cardamom plantations, but no one seemed aware of its being of any value. ***Debregeasia velutina*** was pointed out as the only known wild fibre plant. Subsequently one writer, in response to my account of ***Villebrunea*** (*Agri. Ledg.*, *l.c.*), affirmed that wild-rhea was plentiful in Salsette and the fibre regularly exported up the Persian Gulf, but on being asked for a sample, sent a plant which was neither rhea nor any of the rhea-substitutes, thus once more demonstrating to what extent the bugbear *ban-* (wild) *rhea* has obstructed the natural development of India's fibre resources.

Ban-rhea. Semi-cultivated. Natural Habitat. Various Wild-rheas

A botanical specimen of the present plant was sent from Assam to the Herbarium, Royal Botanic Gardens, Calcutta, by Jenkins early in the 'fifties. On the label of that specimen is recorded the following—"This is the *ban-rheea* from which the China-grass cloth fibres are prepared." I mention this circumstance as of historic value since it proves that the so-called wild-rhea of the early Assam investigators and the *bon* (*ban*) *rhea* pointed out to me on numerous occasions, during explorations in Assam and across the north-eastern frontier into the country of the Mikirs, Nagas, Singphos, Jabakas, Manipuris and other tribes, is the self-same plant of which so much had been said fully half a century ago. In the country indicated the plant is indigenous, but so far as I could discover, is nowhere systematically cultivated though doubtless encouraged to grow and even planted along embankments, roadsides and other suitable situations with a view to affording a ready supply of fibre. In its purely wild habitat it frequents damp glades near streams, though with its roots well above water-level. Because of its being an indigenous plant and called *ban-* (wild) *rhea* there arose the very mistaken notion that it was the source of the cultivated rhea, and still more perniciously the idea that rhea fibre could be procured in India from a wild source for little more than the cost of collection, and further that all that was necessary to secure a never-failing supply was to plant out waste lands with the wild rhea. I have already fully disposed of these absurd notions and need hardly repeat that the wild-rhea of Burma is ***Girardinia***, the wild-rhea of Sikkim *Maoutia*, and the wild-rhea of Assam the present species —three plants that are as remote from rhea proper and from each other as they could well be. They are all nettles it is true, but there the resemblance begins and ends. They are different botanically, chemically, industrially and agriculturally. To continue to think of them as wild forms of rhea is the blindfold acceptance of a name at the probable expense of a future trade. To place this wonderful fibre—wild-rhea of Assam—on the markets of Europe as equal in price, merit and industrial application with the wild-rhea of Burma, would in all probability be to condemn it to complete neglect. It has merits and properties of its own as different from rhea itself and from all other wild-rheas as from flax. It would, therefore, be of great advantage were some entirely distinct name accepted and recognised in Europe as the commercial name of this fibre, such, for example, as that which I have ventured to assign to it above, namely its Naga name RISA.

Separate Name Desirable.

Conditions of Cultivation.—According to the opinion hitherto published, it may be propagated by root-cuttings, by slips, or by seed, and its cultivation conducted on the same lines as with the willow in Europe. It is said to be grown largely by the hill tribes on the north-west of Yunnan, and by the Singphos and Dhoanneas of the Assam north-east frontier to a small extent only (Hannay). The tree when left unmolested attains a girth of about 2 feet and a height of from 30 to 40 feet. It is abundant within the valleys bordering on the Khasia and Garo hills. It is only found in mixed evergreen forests, and is not gregarious. It thrives principally in shady damp places on the sides of streams, but does not grow at all on the plains or in places exposed to the sun. The tree flowers in March, and the seeds ripen in April (Lloyd). I collected the plant repeatedly on the plains of Assam proper, for example on the embankment of the Rajghur in Sibsagar, and at Nahor Rani in Tezpur. It is very plentiful at Tingali, at the foot of the Jabaka Naga hills, growing on loose soil with plenty of water. It could be grown on the sloping banks of most of the depressions or ***hullahs*** within tea estates—lands which at present are not only waste, but often a source of positive danger to the tea plant.

Shade Necessary.

Fibre.

Season of Pollarding.

Extraction of Fibre.

Collection and Separation of Fibre.—The trees are pollarded during the months of November to February, and the young shoots become available in June and through the rains. The fibre is extracted from the branches in exactly the same manner as from *Bœhmeria nivea*, only the fibre is longer. One man preparing *risa* can get as much fibre in the same time as three men preparing the cultivated rhea fibre (Lloyd). The young shoots begin to appear in May, and these alone are used for fibre. The Naga way of preparing the ribbons is quite different from the Assamese. The cuttings are best made from May to October, during the rainy season. The shoots are carried to the villages, where the outside green skin or bark and a little slimy matter are scraped off. Then the ribbons of partly cleaned fibre are stripped from the shoots. The inside of these ribbons is next scraped with a knife so placed in the hand as to allow the edge to rest against the forefinger. The strips are drawn through repeatedly in order to remove the slimy and gummy substances from the inner face. After being cleaned in this way, the ribbons are left to dry in the shade. When fully dried they are next steeped in water and wood-ashes for about twenty-four hours, and then boiled in rice water for four hours. The fibre will be then found to be quite free from gum, and may be separated into fine threads. This is, however, a tedious process and is mostly carried on by the old people of the villages. The Assamese, on the other hand, take off the ribbons when the shoots are in a half-dry state and do not first scrape off the outer bark and gum. They also leave the inner face coated with the slimy substance. They purify it in a coarse way by washing in lime and then twist it into twine, or simply divide up the ribbons and without any preparation twist these into twine. This is employed in making the nets used to catch deer (Severin).

The Naga Method.

Shoots Scraped.

Dried.

Boiled in Rice-water.

Assam Method.

Lime-water.

Yield and Utilisation.—Col. L. A. M. Lumsden, C.B. (of Lumsden's Horse) was good enough to supply the thongs of bark that were furnished for examination and report. These were stripped from wild plants that had not been cultivated nor pollarded to produce special fibre-yielding shoots. The consignment was, therefore, very mixed and an allowance has to be made for this circumstance. The following facts are instructive. The green branches stripped came to 36 maunds 32 seers; the green ribbons of bark obtained from these weighed 3 maunds 30 seers; and the dry ribbons, without any preparation other

Yield of Ribbon.

than drying in the shade, came to 1 maund 30 seers (Lumsden). The fibre is used in the manufacture of a coarse cloth, but chiefly for fishing-nets (Hannay). In the Garo hills the fibre is only prepared in small quantities and for home consumption. The people use it in making nets, and in certain cases for mixing with silk in making cloth (Lloyd). In the Jabaka Naga country it is valued because of its great strength. It is coarsely woven into the bags that are carried over the shoulder. These are often beautifully ornamented, being embroidered with dyed thread of the same fibre (Phillips). The Nagas believe that the harder the thread is spun the stronger it becomes (Severin).

Uses: Coarse Cloth Fishing-nets.

Mixed with Silk.

Properties of the Fibre.—In 1853 Capt. Thomson reported that for canvas or lines the fibre required only to be known to be generally used for these purposes. Royle published the results of a comparative study of the fibre supplied by Hannay as follows:—Petersburg clean hemp, broken with a weight of 160 lb.; Jabbalpur hemp, with 190 lb.; China-grass, with 250 lb.; rhea with 320 lb.; and wild-rhea with 340 lb. These were the results obtained half a century ago, but still no progress has been made with this fibre. In March 1897 I collected personally a supply of bark in the Sibsagar district, and submitted the same for examination to Mr. Melrose Arnot, at that time Chemist of the Bally Paper Mills. He reported that the fibres separated from the bark were beautifully white and of a fine silky lustre and measured 25 to 30 mm. long and 0·013 mm. in diameter. They were cylindrical or nearly so, and tapered at both ends; they had a small central canal and thick striated walls; a pecto-cellulose very similar to flax, but much finer while being equally long. Arnot then added, "As compared with the fibre of ***Bœhmeria nivea*** this is exceedingly fine, indeed it is one of the finest fibres I have ever measured, and although not anything like so fine in the individual fibre, the filaments are long and strong, and I have no doubt that in every respect the material would prove more easily workable on textile machinery, and it would undoubtedly produce very much finer textures than ***Bœhmeria nivea.***" "The colouring matter contained in the bark appears to be well worth serious study."

Comparative Strength.

Microscopic and Chemical Properties.

Better Results than Rhea.

These results were only just what might have been anticipated: no one can scrape the bark off a young shoot and procure a sample of the fibre without realising that it must be very valuable. But in order to have an independent opinion I desired Col. Lumsden to procure me the supply of ribbons alluded to above, and these were forwarded to the late Sir F. A. Abel, Director of the Imperial Institute, London, with the suggestion that Prof. W. R. Dunstan might be invited to examine and report on the fibre.

Further Consignment.

On April 28, 1898, I forwarded the fibre along with a letter in which the following occurs:—"During my explorations in Assam I gave special consideration to the *ban-rhea*. I found, as I had suggested in the *Dictionary*, that while related no doubt to ***Bœhmeria nivea*** it was a perfectly distinct plant, namely ***Villebrunea integrifolia.*** It can be grown on all waste lands; it has little or no gum, will give a high return where Rhea fails; is a very fine fibre, and perhaps as strong, if not stronger, than China-grass. On these considerations I contemplate making an effort to bring this fibre to the attention of commerce, and I shall be very grateful if you can see your way to secure the co-operation of the Officers of the Research Department. I desire to have the fibre examined both chemically and industrially. For the latter purpose I shall be glad to send a larger consignment on hearing from you. The

Recent Investigations.

ribbons have been simply stripped off the stems. They have not been cleaned in any way, and the loss no doubt will be found serious. The plant produces shoots 20 feet long; the bark strips off easily, but no doubt machinery could be readily designed to produce a cleaned and partly bleached raw fibre. Perhaps the most important point in connection with this fibre is that it could be produced at a third the price of *Rhea.*"

In October of the same year I had the pleasure to receive Dunstan's report, and the following passage sets forth his results and conclusions:—"Unfortunately the untreated bark-fibre was sent for examination, consisting of the bark peeled from the plant—containing the bark-fibres in strips from 3 to 5 feet in length. The only course to adopt was to imitate as nearly as possible the retting process adopted on an industrial scale, which the almost complete absence of gum rendered possible. Two samples of fibre were received. A small quantity of each was placed in dishes covered with water and allowed to stand for about three weeks, after which time one of the samples was sufficiently soft for the fibre to be removed. This was carefully combed and picked, and by this means about 10 grams of a nearly clean brown fibre in long silky threads were procured." The fibre thus treated was then submitted to the usual chemical examination, and commenting on the same, Dunstan adds:—"It is interesting to compare these numbers with those obtained in the examination of the fibre of *Bœhmeria nivea* made by Messrs. Cross and Bevan. Watt has pointed out that these two fibres are certainly distinct; the *Ban-Rhea* may be the more important of the two, owing to its growing wild on waste land, to its containing little or no gum, and also because it furnishes a silky fibre at least as strong as China-grass." "A comparison of the results of the examination of these two fibres clearly brings out the superiority of the *Ban-Rhea,* especially in regard to its smaller loss by hydrolysis and its higher nitration number. At the same time it must be remembered that the process adopted in treating this fibre in the laboratory only very roughly approximates to that which would be used on a large scale. Portions of the original samples have been submitted to a fibre expert, who reports that they can be readily treated by a special and simple process which has recently been devised. Further information as to this process can be supplied if this aspect of the matter is thought to be of importance."

Stems Retted.

Report.

Superiority of *Ban-Rhea.*

Readily Treated.

I need only add to the above that I purposely sent the "untreated bark fibre" from the belief that perhaps Dunstan might like to have the opportunity of seeing everything contained in the bark and thus learning its good as well as its bad points. The fact that it lent itself to simple retting is a point of infinite value which might not have been discovered so soon, nor told us with such force, but for the happy accident of my having imposed on Dunstan the necessity of having to separate the fibre for himself. Comment seems almost superfluous. The report demonstrates the superiority of *risa* fibre over ordinary *rhea* in regard to strength, texture and composition. The results cannot but be considered as most important, and should commend this new fibre to the favourable attention of all persons interested in *rhea, rami* and the allied *rhea*-fibres. As a catch crop to the tea industry *risa* has perhaps no rival, certainly no equal. The fact that this fibre may be cleaned by simply retting the ribbons of bark (after the

Simple Retting.

Catch Crop with Tea.

Expensive Methods Unnecessary.

Peasant Industry.

fashion of jute) is perhaps of even more interest than its exceptionally high merit as a textile. Expensive decorticating and degumming machinery and methods are thereby rendered unnecessary. It is thus possible that the fibre could be turned out at a price that would not only undersell *rhea*, but for certain purposes compete with flax, if not with jute itself. At all events the cultivation and separation of a crudely cleaned fibre of great merit might easily enough be accomplished by even the poorest agriculturist. While *rhea* must of necessity command capital and enterprise, *risa* can be developed by the peasant. Indian and English newspapers and periodicals have meantime been flooded with the usual quinquennial dose of the will-o'-the-wisp controversy on the favourable or unfavourable aspects of *rhea* cultivation in India. Hardly a word has been said in commendation of this interesting fibre, which thus seems destined once more to lapse into oblivion.

D.E.P., i., 487–92. Silk-cotton Tree.

BOMBAX MALABARICUM, *DC.*; *Fl. Br. Ind.*, i., 349; Gamble, *Man. Ind. Timbs.*, 90; *Pharmacog. Ind.*, i., 215; Cooke, *Fl. Pres. Bomb.*, i., 120; Duthie, *Fl. Upper Gang. Plain*, i., 98; MALVACEÆ. The Red Silk-cotton Tree, *semul, pagun, rokto-simul, simbal, bouro, semar, sáur, sávara, mundla búraga-chettú, pulá, burla, sálmalí, letpan*, etc., etc. A large deciduous tree common throughout the hotter forests of India, Burma and Ceylon.

Gum.

The tree yields a dark-brown GUM which is sold in the bazárs under the name *mócha-ras*. Another vernacular name for the gum is *supári-ka-phul*, "produce of the betel-palm," the name *supári* being said to be given to the blunt thorns of ***Bombax*** by children who masticate them instead of the fruits of ***Areca Catechu*** (the true *supári*). The gum only exudes from portions of the bark which have been injured by decay or insects, for incisions in the healthy bark do not cause it to flow. It is collected from March to June, and is used as a *katira* or hog-gum. Moodeen Sheriff (*Mat. Med. Mad.*, 1891, 61) says there are three market qualities of *sémul* gum, of which the first fetches Rs. 12 per maund, and the third Rs. 8. The gum is used in medicine. It is very astringent and is used by both Hindus and Muhammadans in diarrhœa, dysentery and menorrhagia.

Fibre Floss.

Silk-cottons.

The inner bark of the tree yields a good FIBRE suitable for cordage, and the seeds afford the so-called red silk-cotton or *semul*-cotton, a fibre too short and too soft to be spun, but useful in stuffing pillows, etc. It has also been talked of as a paper-fibre. The smoothness of the floss is believed to prevent its felting, and hence in the textile industries it could only be employed to mix with other fibres in order to impart a silky gloss. Its only important utilisation, however, is in upholstery. But it should be observed that Buchanan-Hamilton and other writers have considered it as apt to deteriorate and become lumpy, distinct defects in upholstery. There are four plants which may be said to be the silk-cotton plants of India, viz:—(1) ***Eriodendron anfractuosum***, DC.; (2) ***Bombax malabaricum***, DC.; (3) ***Cochlospermum Gossypium***, DC.; (4) ***Calotropis gigantea***, R. Br. [For further information see **Calotropis**, pp. 207–8.]

Food.

Medicine.

The flower-buds of ***Bombax*** constitute an article of FOOD, being eaten as a pot-herb. Some years ago it was reported that the estimated amount annually consumed in the Central Provinces was 5,000 maunds (Nicholl, *Exc. Rept.*, 1878-9). The root of the young tree (*semul-músla*) is said to be a MEDICINE and used as an alterative; it is made into a confection with sugar and *ghi* and administered as an aphrodisiac or as a restorative in phthisis. The young fruits (*maráti-moggu*) are stimulant, diuretic, tonic, and expectorant. The wholesale price is quoted for Madras as about Rs. 3 per maund. The TIMBER is not very durable, except under water. It is used for planking, packing-cases, toys, fishing-floats, coffins, the lining of wells, etc. It is also sometimes made into canoes and water-troughs. The tree is called the *yama-druma* or tree of the infernal regions or of the god of death, because it makes a great show of flowers and produces no fruit fit to eat. The cotton is made into tinder, and the wood used in the Ahmedabad match factory. Of all readily available timbers it is one of the most suitable for that purpose. [*Cf.* Jones, *Select. Ind. Pl.*, *As. Res.*, 1795, iv., 296; also Hardwicke, 1799, vi., 367; *Taleef Shereef* (Playfair, transl.), 1833, 28, 103, 157; Lisboa, *Useful Pl. Bomb.*, 1884, 17; Monier-Williams, *Buddhism*, 516; *Ind. Med. Gaz.*, March 1888; Morris, *Cantor Lect.*, *Journ. Soc. Arts.*, Sept. 27, 1895, 897; Biscoe, *List Hyderabad Trees*, 1895, 3; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 48–9; *Ind. For.*, Nov. 1896, 22, app., 60; *Kew Bull.*, 1896, 205; Innes, *Jungle Prod.*, 1896–7; Mukerji, *Handbook Ind. Agri.*, 1901, 322; Hannan, *Text. Fibres Comm.*, 1902, 70–9; Cunningham, *Plaques and Pleasures of Life in Beng.*, 1907, 182, 303–7; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 68, 368.

D.E.P., v., 171-2. Bones.

BONES AND BONE-CRUSHING MILLS: BONE-MANURES, etc.; Voelcker, *Improv. Ind. Agri.*, 113–8; Basu, *Use of and Trade in Bones, Beng.*; Fuller, *Use of Bones in Cent. Prov.*; O'Conor, *Rev. Trade Ind.*, 1901–2, 29–30; *Leather, Manures and Manuring, Agri. Ledg.*, 1897, No. 8, 163–71; also *Util. Bone-dust Pb.*, *Rept. Dept. Land Rec. and Agri. U. Prov.*, 1891–2, No. 15, 45–8; Mollison, *Textbook Ind. Agri.*, i., 86, 110–3.

Value of some Manures.

For some time the export of bones and bone-manures from India was much deplored by writers on Indian economy. The majority of the scientific investigators whose publications have been enumerated above have, however, pointed out, *first*, that the Indian soils as a whole are not deficient in phosphates of lime; *second*, that bones contain, in view of their cost, too small a proportion of nitrogen to justify their use; *third*, that cereals are not so much benefited by bone-manures as by nitrogenous manures; and *fourth*, that it is the roots which are not grown as field-crops in India that are most immediately and successfully treated with bone. For these and many other reasons it has been contended that to the Indian cultivator, as matters stand at present, it is perhaps more profitable to sell the bones found on his fields than to utilise them as manure. Mollison, however, observes that "The *rayat* could, if he took the trouble, collect in some districts quantities of bones, the cost of which would be cartage and his own labour. He could grind the bones into powder . . . and by simple process of fermentation make the bones more soluble and, therefore, more quickly acting than in their natural condition." If these operations were conducted in the *rayat's* spare time and the value of his labour more or less discounted, I have no doubt that the bone-manure would be found as cheap as any other manure procurable. "Bone-meal has been found specially useful with sugar-cane, and to some extent is used with both tea and coffee."

Bone-meal.

Trade in Bones.

Mills.—In all districts tapped by railways or navigable canals and rivers, bones are systematically collected and conveyed to important centres, more especially seaport towns, where bone-crushing mills and bone-manure factories have been established. In 1891 there were 13 such works that gave employment to 491 persons. Steadily these increased, and in 1900 there were 18 works employing 991 persons. These are distributed as follows:—Seven in Madras, 6 in Bombay, 2 in Sind, 2 in Bengal, and 1 in the United Provinces. Thus bone-meal and superphosphate are regularly manufactured and on a fairly large scale in India, but as the local demand is limited the produce is mainly exported. It is not possible, however, to furnish separate returns for the traffic in raw bones as distinct from the prepared bone-manures. In 1884–5 the exports were 18,383 tons, and from that quantity they have steadily increased. Apparently they attained their highest magnitude in 1900–1, when they stood at 112,051 tons, valued at Rs. 58,41,916. For the years 1902–7 the figures were: 1902–3, 100,391 tons, Rs. 54,97,967; 1903–4, 74,788 tons, Rs. 41,57,119; 1904–5, 68,203 tons, Rs. 37,51,480; 1905-6, 87,552 tons, Rs. 49,78,778; 1906–7, 93,760 tons, Rs. 55,45,241.

Exports.

D.E.P., i., 495-504. Palmyra.

BORASSUS FLABELLIFER, *Linn.*; *Fl. Br. Ind.*, vi., 482; Gamble, *Man. Ind. Timbs.*, 737; *Pharmacog. Ind.*, iii., 519; *Agri. Ledg.*, 1894, No. 20; Brandis, *Ind. Trees*, 1906, 657; PALMEÆ. The Palmyra Palm, Brab-tree, *tál*, *tád*, *dral*, *panai-maram*, *paná*, *pané-mara*, *darakhte-*

tári, *tanbin*, etc., etc. The name "brab," commonly used in Bombay, is derived from the Portuguese *brava*, "wild palm."

It is now known that the Talipot Palm of the older writers was not ***Borassus*** but ***Corypha umbraculifera***. ***B. flabellifer*** is an erect graceful palm, diœcious, with terminal crown of fan-shaped leaves. It is believed not to be indigenous to India, but is now cultivated and run wild throughout the plains of India, Burma and Ceylon. Symonds speaks of the "Palmyra forests" of Tinnevelly. It is probably a native of Africa, although its present African congener, ***B. Æthiopum***. is slightly different. Sadebeck (*Die Kulturgew. der Deut. Kolon.*, 313) says that ***B. flabellifer**, var. **æthiopum**, Mart.*, does not yield the Piassaba-fibre. Wiesner (*Die Rohst. des Pflanzenr.*, ii., 454–5) details a careful microscopical examination of the differences between the fibres of ***Corypha*** and ***Borassus***. A distinguishing feature of the two palms is the swelling in the upper stem of the African form. A common supposition is that the African plant became extinct owing to the tearing off of the young leaves for fibre, and the same fate was once said to threaten the palm in Ceylon. It grows readily if protected from cattle, etc., and is a valuable tree for checking sand-drift. But E. J. Butler (*Agri. Journ. Ind.*, 1905, i., pt. iv., 304–10) describes a fungal disease that threatens to prove very destructive.

Fibres.

Basket-ware.

Braiding Material.

Trade.

Writing Material.

Properties and Uses.—Every part of the Palmyra is turned to account in some way or other, and a Tamil poem enumerates 800 uses of it. There are, for example, five FIBRES:—A loose fibre which surrounds the base of the leaf-stalk; a fibre which may be separated from the leaf-stalk; a fibre called *tár* which may be prepared from the interior of the stem; a fibre or coir derived from the pericarp; and the fibrous material of the leaves. The leaf-fibre is utilised in the manufacture of the basket-ware of Madras, produced at Pulikat in Chingleput, Kimedi in Ganjam, and Bezwada in Godavari, etc. Fine strips of the leaves specially prepared and dyed are plaited into braids and worked up into fancy boxes in nests, cigar-cases and the like. At Diamond Harbour near Calcutta, hats have for many years been made of this material and sold to the European sailors who visit Calcutta. A recent inquiry into the braiding materials of India revealed the fact that after ***Borassus***, ***Corypha***, ***Nipa***, ***Phœnix***, and ***Clinogyne*** were the most hopeful. [*Cf.* R.E.P., *Ann. Rept. and Prog.*, 1897–8, 22.] A few years ago investigations were instituted in India with a view to determining the extent to which the cord-like fibres might be employed in brush-making, as substitutes for the American *piassaba* fibre and the Ceylon *kittul* (***Caryota urens***). So far indications have not been obtained of a very great demand for these special Indian fibres. The stem or *tár* fibre is prepared in some special way by the fishermen so that it becomes pliable and can be plaited into fish-traps. It is neither spun nor twisted, a single thread or fibro-vascular bundle being used; the method of preparation adopted by the fishermen has not as yet been made public. [See also **Brushes and Brush-Making**, p. 187, also **Caryota urens**, p. 286.] The export trade in *tal* coir (or "Palm Fibre," as it is often called) centres largely in Tuticorin (*Ann. Rept. Ind. Mus., Calc.*, 1899–1900, 15). The leaves themselves are found serviceable for fans and in thatching. They were formerly prepared as a writing parchment, being so used by the Dutch Government. In Bengal and elsewhere long strips of the leaf are employed by school-children as washable "slates."

Medicine.

Timber.

Cement.

In MEDICINE the juice of this plant is used as a stimulant and anti-phlegmatic. The root is considered cooling and restorative, as also the gelatinous contents of the unripe seeds. The ash of the spathe is given for enlarged spleen, and the silky substance on the young petioles of the leaves is utilised as a styptic. The TIMBER splits easily but will support a very severe cross-strain, and when old is useful for rafters. It is also hollowed out into water-pipes, channels and gutters, and is made into canoes. It is to some small extent exported and used in making walking-sticks, rulers, umbrella-handles, etc. The juice is used in the preparation of cements.

Food.

The Juice or *Tári*.

Palm Wine.

Vinegar.

Sugar.

By far the most important aspect of the Palmyra palm is as a source of FOOD. On tapping the flower-stalk a juice (*ras*) is obtained, which is either consumed while fresh as a beverage or allowed to ferment, which it will do after sunrise, thus forming an intoxicating liquor (*tári* or toddy). If the toddy be distilled the result is palm wine (*arak*), and by destructive distillation a good quality of vinegar is produced (see p. 1111). The *ras* is also boiled down into a kind of sugar called *gúr* or jaggery (see p. 928). Small round cakes used formerly and to some extent still pass as currency in Tinnevelly district. [*Cf.* Yule and Burnell, *Hobson-Jobson*, 1903,

iii. 446.] The tapping for *ras* does not injure the wood, as in the case of the date-palm, since it is only necessary to bruise the flower-stalk and to crush the young flower or fruit within, and with this object slices of the spathe are made for several days in succession. An earthern pot, into which the sap runs, is tied to the end of the stump, and if the juice is to be drunk fresh the pot is coated with lime inside in order to prevent fermentation. The Palmyra continues to yield sap at the rate of three or four quarts a day for four or five months. It begins to yield when about fifteen to twenty years old and goes on for about fifty years, but once in three years the operation must be discontinued or the tree would die. The female tree yields about half as much sap again as the male. The juice is richer in sugar than that of most other palms ; it is said that three quarts of juice will make one pound of jaggery, which (from canes or palms) is the sugar chiefly used by the poor people of India. The sweetness of Burmese bread seems to depend on the use of toddy-juice to raise it.

Use of Lime.

Yield of *Tári*.

Proportion of Sugar.

The extent to which the spirituous liquor is employed may be judged from the fact that at one time the Bombay Government became so alarmed at the excessive consumption of *arak* in Surat that they ordered large numbers of this useful palm to be destroyed. In this connection it is interesting to observe that Fryer, who visited Surat in 1673, mentions that on drawing near the roadstead they saw groves of Brab-trees, from which the Parsís made a " wine akin to Toddy." This wine the sailors drank, and the result was perpetual disturbances of the peace. The plentifulness of the toddy resulted in the district being overrun by " soldiers and seamen of the Moors." The tree flowers in March ; the young fruits are formed in April and May and matured in July and August. Within the shell of the young fruit there is a jelly-like fluid which is eventually transformed and deposited as a hard albumen. The jelly and soft albuminous layers are often eaten fresh in April–May, or cut into small pieces and flavoured with sugar and rose-water. The seed within the albumen is also eaten, being sold in Bengal under the name *talsans*. In July and August the ripe fruits are gathered and the succulent mesocarp is scraped off to be made into small flat cakes called *pátáli*. The nuts within are found to be solid and almost unbreakable, but after being buried for two or three months they germinate, and the young seedlings are eaten as a vegetable or are pickled. In *The Agricultural Ledger* will be found an account of the way in which these shoots (*dantalás*) are regularly grown as a vegetable crop. The nuts are planted as close together as possible, being laid on the surface of a prepared seed-bed in June–July. The crop is dug about four months later. About 50 fruits are planted to the square yard, and these may produce 100 or more *dantalás*. In a cheap year the gross value of a crop per acre at ordinary market rates would be about Rs. 1,800, rising in a dearer season to Rs. 3,000. The vegetable, which is roasted before being sold, is eaten chiefly by Kolis and low-class people. The nut itself is usually broken open and the embryo cooked or eaten dry or after it has been converted into a flour—not unlike tapioca. [*Cf. Paulus Ægineta* (Adams, transl. and Comment.), iii., 439 ; Baber, *Memoirs* (Leyden and Erskine, transl.), 327 ; *Ain-i-Akbari*, 1590, 70 ; P. della Valle, *Trav. Ind.* (ed. Hakl. Soc.), ii., 291 ; Fryer, *Voy. E. Ind.*, 1693, 76 ; Rheede, *Hort. Mal.*, 1686, i., tt. 9, 10 ; Jones, *As. Res.*, 1795, iv., 311 ; Ferguson, *The Palmyra Palm, Colombo*, 1850 ; Taylor, *Topog. Stat. Dacca*, 1840, 61 ; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 190 ; Bidie, *Calc. Exh. Cat.*, 1884 ; Nicholson, *Man. Coimbatore Dist.*, 1887, 39, 40, 240 ; Ferguson, *All about Aloe and Ramie Fibre*, 1890, 79 ; *Trop. Agri.*, Nov. 1892 ; Symonds, *Agri. Bull. Madras*, 1892, No. 25 ; Morris, *Cantor Lect.*, *Journ. Soc. Arts*, Oct. 18, 1895, 930 ; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 49–50 ; *Planter*, April 24, 1897 ; Symonds, *Ind. Agri.*, July 1, 1898, 217 ; *Kew Bull.* (add. ser., ii.), 1898, 238 ; Sadebeck, *Die Kulturgew der Deut. Kolon.*, 1899, 7, 20-3, 313 ; *Rept. on Settl. Myingyan Dist.*, *Burma*, 1899–1901, 38–40 ; Nisbet, *Burma Under Brit. Rule and Before*, 1901, i., 366 ; *Rev. des Cult. Colon.*, 1901, ix., 231 ; *Imp. Inst. Handbook*, 1903, No. 12 ; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 298–9.]

Arak or Palm Spirit.

Edible Albumen.

Vegetable and Pickle.

BORAX or SODIUM BI-BORATE; Ball, *Man. Econ. Geol. Ind.*, 1881, pt. iii., 498–9 ; *Agri. Ledg.*, 1902, No. 5, 132–4 ; *Min. Indust.*, 1900, 57–9 ; Holland, *Rec. Geol. Surv. Ind.*, 1905, xxxii., 99–101. This salt is known in India under an extensive series of vernacular names such as *sohágá, tinkál, annabédi, kuddia khár, tankankhár, venkaram, velligaram,*

D.E.P., i., 504-11.
Borax.

billigárú, lakhiya, vavut, tan-kana, tinkar or tankar, etc. In some parts of the Panjáb frontier and Tibet it is *taslé* or *sal* (*shal*) (one variety being *chú tsalé* or water-borax, the other *tasle mentog* or flower-borax).

History.—The substance was apparently known to the ancient Sanskrit authors and is unmistakably mentioned by Susruta. From the Sanskrit are derived doubtless its Persian and most of its Indian vernacular names, as also its old English synonym tincal. Perhaps the earliest mention (by a European writer) of this substance, in connection with India, is the reference by Garcia de Orta (in 1563) in which he says it is known to the Gujaratis by its Arabic name of *tincor.* It is mentioned by Abul Fazl in the *Ain-i-Akbari* (Blochmann, transl., 1590, i., 26), and is called *tangar.* Hove (*Tours in Gujarat, etc.*, 129), who visited India in 1787, describes the salt as refined in Káthiáwár. Ainslie (*Mat. Ind.*, 1826) gives a good account of it as a drug and says that the process by which *tinkal* was refined into borax was kept a secret by the Dutch. Royle (*Prod. Res. Ind,* 419) gives a brief notice of the substance, but by far the most complete statement hitherto published may be said to be that given by Baden-Powell in his *Panjáb Products* (1868, 90–4). This reviewed the reports of Cunningham, Hay, Edgeworth, Marcadieu and others.

Supply.

Sources.—Borax proper is a native borate of sodium found, along with common salt, on the shores of certain lakes in Tibet and possibly beyond in Persia and China, and is deposited with sulphur by hot springs in the Puga valley of Ladákh, Kashmir. The Indian area may thus be said to commence in Puga valley of Ladákh and to pass east to the lakes of Rudokh. To the south of Lhasa, at the Yamdokcho, borax is also obtained. Holes are dug in the ground in many parts of the deserts of Tartary, and within these *tinkal* is said to collect.

Trade Routes.

The Western supply (from Puga) enters India by Kullu and is refined at Sultánpur, before being consigned *viâ* Mandi and Bhaji to Simla, or *viâ* Rámpur in Bashahr to Jagádhri and thence to the plains. Smaller quantities from this same source also find their way through Chamba to Nurpur or to Kashmir and Lahore. Tibetan borax enters India across the frontier of the United Provinces. Atkinson furnishes an interesting account of this traffic. The borax, he says, is collected in June to September and sold at certain markets. It is brought by Bhotia traders and purchased by the merchants at Rámnagar, where it is refined.

Uses.
Mordant.
Medicine.
Antiseptic.
Domestic.
Insecticide.
Glazing Material.

Economic and Industrial Uses.—Borax is employed extensively as a MORDANT in dyeing and calico-printing. MEDICINALLY it is viewed as a tonic, useful in loss of appetite and painful dyspepsia, and also as an exceedingly valuable detergent in affections of the skin. The antiseptic and disinfecting property of borax, although fully known, might, as it seems, be much more extensively taken advantage of than appears to be the case. For household purposes its uses are practically limitless. As a substitute for soap and soda crystals, it may be regarded as cleaning without destroying colour, and a little added to the starch gives a pleasing gloss to collars, table-linen, etc. As a preservative for meat it is invaluable, and it is probable that as an insecticide (especially in the tea-garden) it would be found unrivalled. Its most important use may be said, however, to be for glazing pottery and as a simple and convenient enamel for metallic surfaces, such as the dials of watches and clocks or domestic enamelled metal wares. It acts as a flux in the formation of a glass which has a low melting-point and thus affords a material that may be employed even in the ornamentation of the surface of glass or glass vessels, since it can be fused and fixed at a temperature lower than what would re-melt the glass on which it has been painted. But ornamentations produced by borax are generally held to be unstable because of the fact that borax is rendered anhydrous by fusion. In time they gradually absorb moisture and become hydrated and efflorescent, when the glaze splits and crumbles to pieces.

Early Investigations.

Sir William O'Shaughnessy was instructed by the Government of India in 1839 to investigate the question of the production in India of glazed pottery sufficient for use at Indian hospitals. His report will be found in the Appendix to the *Bengal Dispensatory,* and on pages 710 and 711 he also gives a most instructive description of the lime-borate that he employed.

Metal-welding. Glass Beads. Varnish. Soldering. Candle Wicks.

Borax may be said to be invaluable in welding, and is employed by blacksmiths, brassfounders and electroplaters. It is largely consumed in the manufacture of glass beads, imitation precious stones, certain qualities and descriptions of cements (see **Glass Beads**, p. 563). It is, in fact, fairly extensively utilised by the Indian jewellers in the manufacture of artificial gems, and with shellac it forms a most valuable varnish. In soldering oxidisable metals its action is to clean the surface by fusing away the oxides into a borax bead. Similarly it is employed by the Indian jewellers to cleanse gold and silver ornaments. Plumbago pots are found to last very much better if after being annealed in the oven they are painted with a solution of borax. Lastly borax is employed as an ingredient in certain toilet soaps and cosmetics, and one of its most curious and interesting uses is that of its employment in the production of a self-trimming wick in candles. For this purpose the wick is saturated with borax, then made into a candle. When ignited an incandescent bead is formed that greatly improves the light-giving property of the flame, while at the same time the wick, being weighted by the bead, turns over to one side and thus protrudes sideways out of the flame. In that position the wick readily oxidises and is consumed, thus dispensing with the necessity of snuffers. [*Cf. Paulus Ægineta* (Adams, transl. and Comment.), iii., 418, 476; Garcia de Orta, *Coll.*, xviii.; also Comment. by Ball in *Proc. Roy. Ir. Acad.*, i., 404; Birdwood and Foster, *E.I.C. First Letter Book*, 1600, 58; Mandelslo, *Travels Ind.*, 1639, 84; Tavernier, *Travels* (ed. Ball), 1670, ii, 19; Milburn, *Or. Comm.*, 1813, ii., 207; Watts, *Dict. Chem.*, 1883, i., 646-50; *Madras Mail*, June 14, 1889; *Produce World*, Aug. 28, 1896; *Journ. Soc. Arts*, 1897, xlv., 1173-4; *U.S. Yearbook Dept. Agri.*, 1900, 555; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 117; Watt, *Ind. Art. at Delhi*, 1903, 22, 29, 86; etc., etc.]

Trade in Borax. Exports. Imports by Land. Imports by Sea.

Trade.—For some years past the foreign demand for Indian borax has been steadily declining, in consequence of the Italian manufacture from boracic acid and sodium carbonate, as also in consequence of the discovery in California and Nevada of limitless supplies. So recently as 1886-7 the foreign exports of borax were 24,273 cwt., valued at Rs. 5,80,637. During the five years ending 1906-7 they have increased from 5,002 cwt., valued at Rs. 1,13,003 in 1902-3, to 5,613 cwt. and Rs. 1,15,300 in 1906-7. The internal consumption has not, however, declined materially. In 1897-8 the imports across the land frontier to India were 15,273 cwt.; in 1898-9, 16,564 cwt.; in 1899-1900, 20,315 cwt.; in 1901-2, 31,085 cwt., valued at Rs. 3,61,446; so again in 1902-3 they were 29,874 cwt., valued at Rs. 3,52,231; in 1904-5, 19,025 cwt., Rs. 2,24,589; and in 1906-7, 21,506 cwt., Rs. 2,60,864. It will thus be seen that borax is an article of considerable importance in the industries of India, and it is satisfactory to know that the local supplies have proved sufficient to check materially imports from Europe and America. There are, however, signs of a slight renewal of the imports from Great Britain. In 1895-6 these were only 13 cwt.; they rose steadily to 597 cwt., valued at Rs. 9,050 in 1901-2; were 463 cwt. and Rs. 6,792 in 1902-3; 848 cwt. and Rs. 10,840 in 1903-4; 1,500 cwt. and Rs. 18,139 in 1904-5; 1,700 cwt. and Rs. 20,389 in 1905-6; and 2,798 cwt. and Rs. 37,039 in 1906-7.

D.E.P., i., 511-7. Frankincense.

BOSWELLIA, *Roxb.*; *Fl. Br. Ind.*, i., 527-8; Colebrook, *As. Res.*, 1807, ix., 377-82; Birdwood, *Trans. Linn. Soc.*, 1871, xxvii., 111-48, tt. 29-32; Gamble, *Man. Ind. Timbs.*, 1902, 137-8; *Pharmacog. Ind.*, i., 295-303; Cooke, *Fl. Pres. Bomb.*, i., 198; Duthie, *Fl. Upper Gang. Plain*, i., 147; *Agri. Ledg.*, 1900, No. 10; Brandis, *Ind. Trees*, 1906, 129-30; BURSERACEÆ.

African: Imported.

It is probable that several species yield the true Frankincense or Olibanum of commerce, and of these perhaps the most important is ***B. Carterii***. These balsamiferous trees inhabit the Somali coast of Africa to Cape Guardafui and also the south coast of Arabia. The African or Arabian frankincense has long

Various Qualities.

Trade.

been regularly imported into India, and bears the following names:—*kundur, lubán, thus, visesh, esesh, parangi-sham-biráni, kunurakkam-pishin*, etc., etc. Muhammadan writers distinguish several kinds of the imported olibanum, viz. *kundur zakar*, male frankincense, which is the best quality and consists of deep yellow tears; *kundur unsa*, female frankincense, *kundur madharaj*, the exudation artificially made into tears; *kishár kundur* or *kashfa*, the *dhúp* of the Bombay market, consisting of the bark of the tree coated with the exudation; and *dukák kundar*, the dust of the olibanum and substance reserved for the Indian and Chinese market, whilst the finer qualities (such as the *kundur zakar*) are assorted and exported from Bombay to Europe. Frankincense is thus an article imported and subsequently re-exported, and is not strictly speaking an Indian product, though it is largely traded in by Indian merchants. It may be useful to furnish, therefore, a few details of the TRADE of which Bombay is the centre and draws 90 per cent. of the imports and has, moreover, a monopoly in the re-exports. During the five years 1898–9 to 1902–3 the imports expanded from 20,487 cwt., valued at Rs. 2,12,423, to 28,582 cwt., valued at Rs. 3,79,279, and have since (1906–7) increased to 32,582 cwt., valued at Rs. 4,12,082. Similarly the re-exports amounted in 1898–9 to 20,218 cwt., valued at Rs. 3,63,168, in 1902–3 to Rs. 5,27,827, and in 1906–7 to Rs. 6,40,540, and were sent chiefly to the United Kingdom, Austria-Hungary, China (Hongkong), and recently to Germany and Russia. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 217; Garcia de Orta, *Coll.*, lv., also Comment. by Ball in *Proc. Roy. Ir. Acad.*, i. (3rd ser.), 677; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), 1598, ii., 99–100; Birdwood and Foster, *E.I.C. First Letter Book*, 337, 340, 406, 410; Celsius, *Hierobot.*, 1745, i., 23; ii., 22, 29; Milburn, *Or. Comm.*, 1813, i., 139; White and Humphrey, *Pharmacop.*, 1901, 496; etc., etc.]

Indian Olibanum Tree.

B. serrata, *Roxb., ex. Colebr.* (*l.c.* t. 377).—This is sometimes called Indian Olibanum Tree, and (more especially the gum) is known as *salhe, sálai, kundur, lubá, anduku, gúggar, guggula, dhúp, chittu, bastaj*, etc., etc. There are said to be two varieties:—(*a*) ***serrata*** proper, a moderate-sized gregarious tree of the intermediate northern and southern dry zones; and (*β*) ***glabra***, a native of N.W. India. It is often met with in tracks of country where few other trees exist, and on that account is valuable.

Medicine.

Food.

Timber.

The GUM (resin) (*sálai-gugul*) occurs as a transparent golden-yellow semi-fluid substance which slowly hardens. It exudes only on injury to the tree and in the Panjáb is collected twice a year, in March from an incision made in the previous October, and in June from an incision made in March. It is computed that each tree yields annually about 2 lb. It is, however, probable that nearly all that has been written about its MEDICINAL properties refers to the imported olibanum, from which it must be carefully distinguished. The Sanskrit word *kunduru* is probably wrongly applied to it, and conversely, although it would appear to be the *guggulu* of Sanskrit authors, gum-*gugul* of the present day is Indian *bdellium* (***Commiphora Mukul***). It is pungent, slightly aromatic, has a balsamic-resinous odour, is consumed almost entirely in Central and Northern India and hardly if at all exported. As a result of various inquiries some samples were sent to Dunstan, who reported that Indian olibanum "closely resembles Frankincense in its chemical properties. There is little demand for such a product in England, but it might find a market on the Continent as an ingredient for incense." It is employed in rheumatism and nervous diseases and is an ingredient in certain ointments. In Gujarat it is burnt as incense in religious ceremonies. The TIMBER, which is rough and moderately hard, is recommended for tea-boxes. It is used for fuel and for making charcoal, as well as to some extent in the manufacture of doors, shutters, bowls, dishes, etc. Fernandez (*Man. Ind. Sylv.*, 99 (quoted by Gamble)) observes that the tree enjoys a considerable immunity from being browsed or lopped for fodder owing to its resinous leaves, and moreover has a great capability for withstanding forest-fires. It is thus valuable in the reclothing of dry hills. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 146; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 96–9; Biscoe, *List Hyderabad Trees*, 1895, 3; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 50; etc., etc.]

D.E.P., i., 520–34.
Mustard and Rapes.

BRASSICA, *Linn.*: *Fl. Br. Ind.*, i., 155–7; Prain, *Agri. Ledg.*, 1898, No. 1; CRUCIFERÆ.

This genus contains some of the most useful of esculent plants, such as the Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Colewort, Colza, Kale, Kol Rabi, Mustard, Rape, Savoy Cabbage, Turnip, etc. There are probably nearly 100 species, a good many of which are cultivated, with under these perhaps as many more races or special forms recognised by the farmers and gardeners of the world. They are all natives of the north temperate zones, but pass into the tropics as cold-season crops. There would appear to have been three great centres of production—a European, an Oriental and a Chinese. The present review of Indian information is intended to set forth the leading commercial facts regarding the more important plants, viz. the Mustards and Rapes, and can, therefore, only incidentally indicate the other species.

Recent Research.

In the *Dictionary* (1884) it was urged that from an agricultural point of view the Asiatic forms may be referred to three important sections: (*a*) *Sarson*, (*b*) *Toria*, and (*c*) *Rai*. The information given in that work was essentially a compilation, and in no sense a report of personal investigations. Since that date, Lt.-Col. D. Prain while Curator of the Herbarium, Royal Botanic Gardens, Calcutta, was able to devote much attention to the study of the Bengal cultivated forms. He had sent to him seeds of the mustards, etc., grown in practically every district of that province. These he specially cultivated at Sibpur, and was thus enabled to study the plants critically, from germination to harvest. As a result he published a very comprehensive report of his investigations, illustrated by twelve plates and two maps. [*Cf. Agri. Ledg.*, 1898, No. 1.] By a comparison with Duthie and Fuller's account of the species met with in the Upper Provinces (*Field and Garden Crops*) and other such publications, it would seem that what Prain has said of Bengal is, in the main, applicable to the whole of India. But following up Prain's studies, Dr. W. Kinzel, of the Agricultural Station at Dahme, has furnished the results of microscopic and chemical studies of authenticated seeds supplied to him by Prain. [*Cf. Die Landwirtsch. Versuchs-Stationen*, lii., 169–93, transl. and republished in *Agri. Ledg.*, 1901, No. 7.] It has thus been rendered possible, through the combined labours of Prain and Kinzel, to identify the Indian rapes and mustards with a degree of assurance not hitherto admissible.

Chemical and Microscopic Studies.

Vernacular Ambiguities.

Until such personal investigations had been made it was not to be wondered at that numerous ambiguities, due to faith having been too implicitly placed on vernacular names, should have disfigured the literature of the subject. Prain expressly tells us that the *rai* of one district may be the *tori* of another, or the *sarson* of a third. "Although often, perhaps indeed usually, rigidly enough applied within a given district, Native names are worse than useless when they are depended on to yield information regarding another group of districts." This is doubtless true, but is perhaps due more to the ignorance or carelessness of the contributors of samples than to the cultivators of the plants. The writer is fortunate who, like Prain, may be able to analyse Native opinion in the light of authentic specimens. It is most satisfactory, therefore, that the literature of this hitherto very obscure subject has been placed on a rational basis. "Practically," says Prain, "there are but three mustards cultivated in Bihár and Bengál. These three constitute the familiar *Rai*, *Sarson*, and *Tori* crops. Each one of the three varies within its own limits to a greater or less extent: none of them shows the slightest tendency to pass from one to another. So far, at least, as the Lower Provinces are concerned, the existence of anything in the nature of a form intermediate between *Rai* and *Sarson*, *Rai* and *Tori*, or even between the more closely allied *Sarson* and *Tori*, is wholly imaginary." Many of the errors that have been made by botanists would seem to have arisen from greater faith having been put on the study of dried herbarium specimens than on practical knowledge and experience of the living plants. So also the association of the Indian with the European forms has led to confusion. Prain accordingly concludes his most admirable paper as follows: "As regards the relationship that our three staple mustard-oil crops bear to the corresponding crops in Europe, it may be tentatively held:

No intermediate Forms.

Indian *versus* European Forms.

"(1) That *Rai* (***Brassica juncea***) is a crop not grown in Europe, at any rate on a commercial scale, but that it takes the place here of ***B. nigra*** and ***B. alba***, which in turn are not grown in India;

"(2) That *Sarson* (***B. campestris**, var. **Sarson***) is a crop not grown largely, if at all, in Europe, but that in India it takes the place both of ***B. campestris**, var. **oleifera***, and ***B. rapa**, var. **oleifera***, which in turn are hardly ever met with here: finally, "(3) That *Tori* (***B. Napus**, var.* ***dichotoma***) seems to be the same plant as ***B. præcox*** (Summer-rape), or if not the same is at least very like and very near it, and is undoubtedly the plant that in India takes the place of ***B. præcox*** and of ***B. Napus**, var.* ***oleifera***" (Prain, *l.c.* 78).

With these introductory and explanatory observations it may now be desirable to discuss the chief Indian forms in alphabetical sequence of their scientific names :- –

D.E.P., i., 521-2, 530-2. Black and White Mustard.

B. alba, H., f., & T.; Duthie and Fuller, *Field and Garden Crops*, pt. ii., 34; Prain, *l.c.* 9-10. White Mustard; also **B. nigra, *Koch.*** Black or True Mustard. These two species, if met with at all in India, occur in gardens only within the temperate areas or in Upper India during the winter months. They are nowhere field crops, nor do they contribute in any way to the Indian supplies of Mustard or Oil.

I. INDIAN FORMS OF SARSON AND RAPE.

D.E.P., i., 522 8.

B. campestris, Linn.; Prain, *l.c.* 22-44, 46.

From the standpoint of commerce it is a matter of supreme indifference whether ***campestris, Napus***, and ***rapa*** be treated as separate species or subspecies of one and the same species. The European cultivated races of the assemblage may be grouped as follows: ***oleifera***, the Colza; ***Napo-brassica***, the Swedish Turnip and Rutabaga; ***Napus*** the Rape, and ***Rapa*** the True Turnip. The turnip or *shalgham* is extensively cultivated in India as a cold-season crop. The Brahmans and Baniyas are said to have a prejudice against it. In no part of India are either the Swedish or True Turnips grown as field crops intended to feed cattle. Prain had sent to him from Chittagong, seed of a mustard that proved on cultivation to be almost identical with the European Colza. From Sikkim and Bhutan he procured seed of a plant that turned out to be ***B. Napus**, var.* ***esculenta**, DC.*, the Sweet Navet.

The following are the chief varieties and races :—

D.E.P., i., 524. Sarson.

Indian Colza or Sarson; *Sinapis glauca, Roxb., Fl. Ind.*, iii., 118, also *S. trilocularis, Roxb., l.c.* 121; *B. campestris subsp. Napus, Fl. Br. Ind.*, i., 156 (in part); *B. campestris, subsp. Napus, var. trilocularis,* also *quadrivalvis, Duthie and Fuller, Field and Garden Crops*, pt. ii., 28-9; *B. campestris, subsp. Napus, var. glauca, Watt, l.c.*; *B. campestris, Linn., subsp. campestris, var. Sarson, Prain, l.c.* 24-35, 46, 77-8.

Prain (*l.c.* 77) says the plant thus briefly indicated "occurs in every province of Bengal except Chittagong, where it is replaced by a different mustard. It is easily distinguished from *Rai* by its stem-clasping leaves, and from *Tori* by the greater amount of "bloom" on its foliage, by its taller stature, its more rigid habit, and its thicker, plumper pods. When reaped the seeds are distinguished by their usually white colour; when brown the seeds are distinguished readily from those of *Rai* by the larger size and the smooth seed-coat; from those of *Tori* by their being of a lighter brown, and by not having a paler spot at the base of the seed."

Distinctive Features.

"There are two races—one with erect pods, the *Natwa Sarson* or *Sarson* proper, and one with pendent pods, the *Ulti* or *Térö Sarson.* Each race has two distinct subraces—one with 2-valved, the other with 3-4-valved pods."

"The forms with hanging pods are not common except in North Bengal and East Tirhut (Purnea), the subrace with 2-valved pods being almost confined to this area. But the 4-valved kind extends sparingly through Western Tirhut, and crossing the Ganges spreads southwards through South-West Bihar and Western Chota Nagpur."

Distribution.

"The forms with erect pods practically occur everywhere: the 2-valved subrace, however, is little known in Bihar, though it is grown both in Shahabad to the south-west and Monghyr to the south-east. It extends over the whole of Chota Nagpur and over Orissa and West, Central and East Bengal. The 4-valved subrace occupies West Tirhut and West Bihar, extending thence sparingly through South-East Bihar and along the dry parts of West Bengal, as far south as Midnapore. It also occupies North Bengal and the northern part of East Bengal (Mymensingh), to the exclusion of the 2-valved subrace. Roughly speaking, therefore, the 2-valved erect subrace is characteristic of Chota Nagpur, Orissa, West, Central and East Bengal; the 4-valved erect subrace is characteristic of the western half of Bihar, and again of North Bengal, while the pendent subraces occupy the region between the areas to the north of the Ganges occupied by the erect 4-valved subrace."

"The name *Sarson* prevails in Chota Nagpur in Bihar, and in extreme North Bengal. In Bengal proper this is the mustard known as *Sweti Sarisha*, or simply *Sweti*. In Orissa it is *Ganga toria*."

Microscopic Examinations.

Dr. Kinzel says, "It is so easy to recognise this species as such, that perhaps with a little more experience it may become possible to distinguish microscopically the seeds of the various races of sarson. In brown-seeded sarson the structure of the testa is very uniform, and is almost equally so in the white-seeded and yellow-seeded kinds. The mucous epidermal layer has been found to be undetached in every one of the races." In *The Agricultural Ledger* (1901, No. 7, 111, pl. i., ff. 1–3) are shown the form and structure of the seed-testa of various qualities of *sarson*. This, it will be seen, is composed, like that of all the species of *Brassica*, of a soft parenchyma below, a layer of glutinous cells, a layer of colouring matter, a layer of palisade tissue (the cells of which are narrow, elongated and acute, the shape and size varying with each form of mustard), and lastly an epidermal layer. To appreciate the value of the relative developments of these structures in the various species and races, it is necessary to inspect Dr. Kinzel's plates. Concluding his account of *sarson*, he observes that "the quality of mustard-oil varies from 0·564 to 0·875 per cent., and shows remarkable uniformity in some of the races. In nine sorts examined the mustard-oil averaged 0·708 per cent. The quantity present was lowest in the race with the longest seeds (*Lalka Tora*, the large-brown race)." Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 726) reviews Kinzel's paper and thus indirectly accepts some of Prain's main conclusions regarding this and the other special Indian forms of Rape and Mustard. The *Taleef Shereef* (Playfair, transl., 1833, 92, 94) mentions *sarson* under the names *sedarth* and *sir kup*.

Sowing.

Yield.

Cultivation and Area.—N. G. Mukerji (*Handbook Ind. Agri.*, 271), endorsing previous published opinions, says that *tori* (*latni*, *sarisha*, *shorshé*) and also *sarson* (*shweti shorshé*) are usually sown with wheat or barley, or in gardens with carrots, amaranth, etc., while *rai* is grown by itself. They are sown in September, *i.e.* six weeks to two months before the regular *rabi* sowings. He then observes that when grown as mixed crops 1½ lb. of seed to the acre are required, the yield being 1½ to 2 maunds. When sown as pure crops 4 to 6 lb. of seed are necessary and the produce 4 to 6 maunds. With *rai* the seed should be 3 lb. and the crop 3 to 4 maunds.

Area.

Method of Sowing.

Pure and Mixed Crops.

The greatest possible difficulty exists in furnishing definite particulars regarding the area of production and methods of cultivation of *sarson* in India as a whole. Duthie and Fuller's account of the United Provinces of Agra and Oudh may very possibly be admissible as indicative of the main features of interest, when taken in conjunction with such particulars as may be derived from Prain's account of the mustards, etc., of Bengal. From the *Field and Garden Crops* we learn that *sarson* is a cold-season crop, grown usually mixed with wheat or barley. It is sown either broadcast or in parallel lines running across the fields. It is cut shortly after the harvest of the associated crop. But it is difficult either to fix the actual area under it, or to ascertain the yield. The districts of the middle and lower Doáb are specially well suited to it, and in these hardly a wheat or barley field can be seen in which some portion is not devoted to *sarson*. The extent of that cultivation may be inferred from the fact that in 1901–2 while only 125,585 acres were returned as pure "sarson, rape or mustard," 8,267,844 acres were shown as mixed crops of these oil-seeds along with wheat, barley, etc. If, however, we accept the yield in the mixed crop to have been approximately in the same ratio as that of the pure crops, the net area (worked back from the published production) would have been 1½ million acres (calculated as pure crops) yielding 467,450 tons of "Rape and Mustard." That calculation represents a yield of, say, 5 cwt. an acre. *Sarson* is, however, an extremely precarious crop, being very liable to pests and blights as also to climatic vicissitudes. For example, it is peculiarly subject to the ravages of an aphid that sucks the sap of the young shoots to such an extent that they fail to produce seed. It is, however, exceedingly profitable, and whenever possible the cultivators put at least some portion of their lands under it.

Pests.

D.E.P., i., 523, 525. Rape.

Indian Rape or Tori, Lutni or Maghi; *Sinapis dichotoma, Roxb., Fl. Ind.*, iii., 117 ; *S. campestris, subsp. Napus, Fl. Br. Ind.*, i., 156 (in part) ; *Brassica campestris, subsp. Napus, var. dichotoma* also *Toria, Duthie & Fuller, Field and Garden Crops*, pt. ii., 29 ; *B. campestris subsp. campestris, var. dichotoma* also *Toria, Watt, l.c.* ; *B. campestris, Linn., subsp. Napus, var. dichotoma, Prain, l.c.* 36–40, 46, 76–7.

Cold-season Crop. Distinctive Features.

Prain (*l.c.* 76) says that after *rai* this is the most important of Indian grades of mustard. It is a cold-season crop on the plains of India and a spring crop on the Himalaya. It was sent for cultivation and study from all the districts of Bengal except Saran and Shahabad. "It is easily distinguished from *Rai* by its stem-clasping leaves and its small size ; when reaped the seed is recognised as being larger, though of the same colour, and by having a paler spot at the base of the seed ; the seed-coat, too, is only slightly rough. From *Sarson* or Indian Colza it is easily distinguished by its smaller size and by its leaves, though stem-clasping, as in *Sarson*, being less lobed and having much less bloom. The seeds are of much the same size in *Tori* and in ordinary *Sarson*, but as a rule the seeds of *Sarson* in Bengal are white. When *Sarson* seeds are brown they are of an amber colour, and have no paler spot. The seed-coat, too, is smooth. The seeds of *Sarson* are *sometimes* considerably larger than those of *Tori*. When this is the case, the two are easily distinguished."

Season.

"There are two kinds of *Tori*—a taller, rather later, and a shorter, very early kind. Both kinds, however, ripen well ahead of any *Rai* or any *Sarson*. The earlier kind of *Tori* does not appear to occur in North-West Tirhut ; the later kind is unknown in East Bengal or in Chittagong; elsewhere both sorts prevail throughout the Lower Provinces."

Distribution.

"This mustard is known as *Tori* in Bihar and the northern districts of North Bengal, *Lutni* in Chota Nagpur and the drier parts of West Bengal, *Sarisha* in Orissa, West Bengal, Central Bengal and the south-western districts of North Bengal, *Maghi* in the south-eastern districts of North Bengal and throughout East Bengal. The Bengal name *Sarisha* recurs in Chittagong."

Microscopic Examination.

Kinzel (*l.c.* 108) informs us that "as compared with European Rape and Colza, the amount of mustard-oil the seeds contain appears very variable. As compared with other species, the testa of the seeds has remarkably narrow, very distinctly circular markings. The only species with circular markings almost as small is **B. rugosa**, *Prain*, which is at once diagnosed by its detachable epidermal layer. All the samples dealt with here have in transverse sections an *undetached* epidermal layer with narrow lumen." "The transverse sections of the samples examined were, moreover, very uniform. As compared with the other species, the cells of the palisade-tissue have a very thin wall, and consequently a clearly defined wide lumen, exactly as in **B. Napus**, Linn., the European Rape. In transverse section they appear very blunt at the apex. The layer with colouring matter is very loose ; the viscid cells are often in two layers ; the thin-walled parenchyma is disposed in three to four layers." Kinzel gives the range of mustard-oil as from 0·239 to 0·848 per cent.

Yield of Mustard-oil.

Cultivation and Area.—It has not been found possible to isolate some of the facts regarding this plant from those of *sarson*. The foregoing observations have, therefore, to be read in connection with the special particulars that have been elucidated regarding *tori*—the present plant. Duthie and Fuller urge that so far as the United Pro-

U. Prov.

Area.
Production.
Pure Crops.
Mixed Crops.
Hill Districts.
Exports.

vinces are concerned, the present plant is mainly grown as a pure crop, while *sarson* and *rai* are almost entirely produced as mixed crops. It follows therefore that the area in these provinces shown as "pure" can be taken as *tori* (*lutni, lahi*) or rape. According to the *Agricultural Statistics of India* (1901–2 to 1905–6), compiled by the Director-General of Statistics, there were in the United Provinces during 1901–2, 120,436 acres and 36,841 tons of pure rape; in 1902–3, 140,296 acres yielding 31,320 tons; in 1903–4, 131,926 acres yielding 29,643 tons; in 1904–5, 140,100 acres yielding 18,800 tons; in 1905–6, 154,700 acres yielding 30,000 tons; and in 1906–7, 153,400 acres yielding 30,000 tons. But the area of mixed crops, that is to say of mustard and rape, grown along with other crops was much greater, namely, in 1901–2, 1,461,000 acres and 430,617 tons of seed; in 1903–4, 2,429,000 acres and 542,000 tons of seed; in 1904–5, 2,509,000 acres and 336,000 tons of seed; in 1905–6, 2,026,000 acres and 398,000 tons of seed; and in 1906–7, 2,210,000 acres and 424,000 tons of seed. Rape is "produced in greatest abundance in the districts which border on the Himalayan Terai, and is cultivated all over the hills up to altitudes of 11,000 feet" (Atkinson). It is very little grown in the districts of the Ganges-Jumna Doáb, where it generally occurs as a subordinate crop in vegetable gardens. Concluding their account of this product these authors say, "The export of rape is one of the leading features in the commerce of these Provinces, and centres at Cawnpore."

Panjáb.
Chief Districts.
Unirrigated Land.
Panjáb Trade.
Panjáb Areas Reviewed.

"Rape Seed" is an important article of export trade from the Panjáb and it is grown in Kashmir and Afghanistan. Unfortunately no Panjáb writer has as yet studied the mustards botanically, and it is not, therefore, possible to discover to what extent the reports that have appeared should be accepted as rape or be assigned to *colza* or even to mustard. These crops are largely grown in Ferozepore, Hissar, Jhelum, Rawalpindi, Dera Ismail Khan, Lahore, Gujrat, Dera Ghazi Khan, Jhang and Karnal Districts, in the order of importance named. Fully three-fourths of the crop is raised on unirrigated land, a fact that must commend it very greatly to the cultivators. The traffic centres very largely in Ferozepore and the exports go mainly to Karachi. The year 1900–1 was one that might be described as having been abnormally favourable to rape-seed cultivation in the Panjáb. The area under the crop became more than double the average of the preceding years, and was returned at 1,699,700 acres. The yield was also remarkably fine, so that it was described as 25 per cent. above normal, and the total yield became 260,167 tons. Since 1900–1 both area and yield have somewhat declined, though in 1905–6 the area was again recorded as 1,699,700 acres, but the yield only 194,900 tons.

C. Prov.
Bombay.
"Gujarat Rape."
Chief Rape Area.

Nothing of any value can be learned regarding the rape, *sarson* and mustard cultivation in the Central Provinces, Berár, Rajputana, Central India, Sind and Bombay. Mollison (*Textbook Ind. Agri.*) does not refer to these crops. "Gujarat Rape" of the Bombay and Karachi trade returns would appear to be mainly a special and superior quality of the present plant. But the total area under the crop in the province of Gujarat is not great, being usually about 500 acres, so that the expression "Gujarat Rape" denotes a quality of seed not necessarily procured from the province indicated (see p. 183). However, the total area returned for Sind and Bombay (including their Native States) as devoted to rape and mustard is well under 200,000 acres, or less than the acreage of these crops in the Ferozepore district alone. So far, therefore, as can be learned, the sub-mountain tracts of the United Provinces and the greater portion of the Panjáb may be taken as the Indian region of rape production.

Bengal.

Bengal province is mainly concerned in the *sarson* and *rai* trade. But it may be pointed out that in official statistics the acreage of pure mustard crops in the United Provinces is that which is alone accepted. Hence, as already indicated, the *sarson* and *rai*, which are always mixed crops, are excluded from consideration, whereas in Bengal and the Panjáb they are included. In consequence of this arbitrary treatment the "Rape and Mustard" cultivation of the United Provinces is shown as very much smaller than that of the Panjáb, while as a matter of fact it is quite as large and possibly larger. If, therefore, a correction be made of, say, 1,500,000 acres, added to the total area of India under Rape, Colza and Indian Mustard, the result would be 5 to 5½ million acres instead of a little over 4 million acres as presently accepted. If this conclusion be upheld by future inquiry, Bengal would still head the list of Indian provinces with about 2 million acres, and would be followed by the United Provinces with very probably 1½ to 2½ million acres, and by the Panjáb with 1¼ million acres, while all the other provinces and Native States put together would conclude the enumeration with less than half a million acres between them.

Total Indian Area devoted to these Crops.

D.E.P., iii., 266-7. Eruca sativa.

Brassica Substitute - Eruca sativa, *Lam.: Fl. Br. Ind.*, i., 158; *Brassica Eruca, Linn.*; *B. erucoides, Roxb., Fl. Ind.*, iii., 117; Duthie and Fuller, *Field and Garden Crops*, ii., 26, pl. 36; Dioscorides, *Codex Aniciæ Juli*, 512 A.D., pt. i., pl. 118; *Paulus Ægineta* (Adams, transl.), iii., 118, gives the key to classic and Arabic literature. This is known in Europe as the Rocket and in India as the *tara-mira, tara-moni, duan, dua, jambho, jamba, usan, shwan, chara*, etc. According to Prain, the name *sheti sarisha* given by Roxburgh to this plant is nowadays restricted to *sarson*.

Cold-season Crop.

The *tara-mira* is a native of S. Europe and N. Africa, and is extensively cultivated as a cold-season crop in Upper India, ascending the Himalaya to altitudes of 10,000 feet. It is fully dealt with by Duthie and Fuller, but is only incidentally mentioned by Prain, a circumstance that may be accepted as denoting its comparative absence from Bengal. However, all the standard authors on Upper and Western India (such as Stocks, Stewart, Baden-Powell, Atkinson, etc.) describe the plant and the methods pursued in its cultivation. It is most commonly grown mixed with grain or barley, taking with these crops the place which rape fills in wheat-fields. It is also met with very largely in association with cotton. It is sometimes grown alone, but only on exceptionally dry fields. It may be sown at any time between the beginning of September and the end of November, and it ripens about the same time as the *rabi* crops. The yield is said to be from 4 to 12 maunds an acre. *Usan* is very largely used as green fodder, especially when grown with gram or peas, and the oilcake is much appreciated for feeding cattle. The plant is grown as a substitute for *sarson* or rape, and the oil is used mainly for burning, but to some extent for food.

Associated Crops.

Yield.

Trade.

The trade in this seed seems mainly within India and as a substitute for *sarson*, while for foreign countries apparently as a grade of rape. It appears under the name of *jamba* very frequently in the export manifests from Karachi, the supply being apparently drawn from Sind, Rajputana and the Panjáb.

D.E.P., i., 528-30. Indian Mustard, or Rai.

II. INDIAN MUSTARD.

B. juncea, *H. f., & T.; Sinapis juncea, Linn.; S. ramosa, S. patens, Roxb., Fl. Ind.*, iii., 119, 124; Duthie and Fuller, *Field and Garden Crops*, ii., 33; Prain, *l.c.* 16-22, 47, 76; Indian Mustard, *rai, asl-rai*, etc.

Distinctive Features.

Prain (*l.c.* 76) concludes his admirable account of this species with the following brief statement of the main facts brought to light by recent investigations. *Rai* or Indian-mustard is the most important of the three species of ***Brassica*** grown in Bengal. It is met with "in all the provinces except Chota Nagpur, where it is practically unknown, though it seems to be cultivated to a slight extent in Singhbhum. It is easily recognised by having none of its leaves stem-clasping; and, after reaping, its seeds, which are brown, can be readily distinguished from those of *Tori* or Indian Rape by their smaller size, their being distinctly rugose, and being reddish-brown all over. From *Sarson*, which has white seeds or, less often in Bengal, brown seeds, it is equally easily distinguished; *Sarson* seeds are always considerably, often very much, larger, and even when brown have the seed coats smooth."

Races.

"There are three subraces, a tall, late kind, and two shorter earlier kinds, one of these latter roughish with bristly hairs, the other smooth with darker coloured stems. The taller subrace is quite absent from Chota Nagpur, and from Tippera and Chittagong. The shorter subraces are quite absent from Orissa, and are absent from North Bengal, except Dinajpur, and from East Bengal except Tippera."

"The name *Rai*, occasionally *Lahi* or *Li*, once also *Mai*, occurs everywhere except in Orissa, where this mustard is termed *Chota Sarisha* (*chota* = "small," with reference to its seeds). In various districts other names are locally applied, either alone or as alternative names for *Rai*."

Microscopic Examination.

Kinzel (*l.c.* 113) in describing the seeds of Indian mustard furnished to him by Prain, says that the testa examined under the microscope in surface preparations after treatment with sulphuric acid and caustic soda shows "very peculiar circular markings very readily distinguished from those of any European ***Brassica*** except ***B. Besseriana*** (Sarepta Mustard), which, however, differs in having a separable mucous epidermis. It may be noticed in passing that, as a rule, it is not necessary to make transverse sections in order to demonstrate this separability, because among a large number of surface preparations some fragments that lie transversely are always to be met with when looked for. The colour of the testa of *Rai* is on the whole clearer than that of European Rape and Colza. The lumina of the cells of the palisade tissue, as indeed the whole testa, show in section characteristic features that in practice impress themselves on the memory, though they could hardly be reproduced except by photography." "The quantity of mustard-oil present in *Rai* varies from 0·572 to 1·059 per cent., and gives an average in six kinds examined of 0·814 per cent."

Mustard-oil present.

Cultivation.

Cultivation and Area.—This mustard is cultivated here and there throughout India, and is met with (or closely allied forms are) westward to Egypt and Europe, and eastward to China. It enters directly into competition with Russian mustard (***B. Besseriana***) a plant extensively cultivated in South and South-East Russia (the Sarepta Mustard). Though the cultivation in India is fairly extensive, it is extremely difficult to procure satisfactory information regarding the extent of production in the various provinces. As already fully exemplified, the returns of "Rape and Mustard" are given conjointly along with those of colza (*sarson*), but it would seem certain that Bengal and Assam are the most important provinces and South India the least important. In Upper India (the United Provinces, Panjáb, Rajputana and Sind) the rape crop becomes more important than the mustard. Duthie and Fuller, speaking of the United Provinces, say that this species varies very much in height, some of the kinds attaining 5 feet or more. It also varies in the shape of the pod, which, usually cylindrical, sometimes becomes stout, laterally compressed and less torulose than in typical kinds. They further observe that this mustard is rarely grown alone (except in Benares), but is subordinate to wheat, barley and peas. It is not nearly so extensively cultivated as rape and is usually restricted to the borders of fields. It yields less oil than rape (one-fourth instead of one-third) to the weight

Extensive in India.

Most Important Provinces.

Rape *versus* Mustard.

Yield of Oil.

of seed; moreover the oil is less esteemed as an article of food. The seed is very generally used in India as a spice to give flavour to vegetables, and sometimes also as a medicine. Mustard-flour. Mustard-flour is not consumed by the people of India, and the traffic for that purpose is therefore entirely foreign. It would seem, however, that both the Indian and the Russian seed are largely used as one of the ingredients in some of the modern preparations of mustard-flour sold in Europe. The plant is very often (like rape) cut Fodder. green in January and given to cattle, and in some localities the young leaves are eaten as a vegetable. (For further particulars see the paragraph below on **Oil** and **Oilcake**).

D.E.P., i., 533.

B. oleracea, *Linn.* The Cabbage, Cauliflower, etc., etc.

It will serve the purpose of this work to indicate very briefly the chief cultivated plants of this species met with in India. In all the forms the leaves are glaucous or green and destitute of hairs: the leaves of the inflorescence only are stem-clasping. The chief forms are:—*var.* ***acephala***, which includes the Kale, Borecole, Cow-cabbage, etc.; *var.* ***bullata***, best known through the Savoy Cabbage and Brussels Sprout; *var.* ***Botrytis***, the Cauliflower and Broccoli; *var.* ***capitata***, all forms and colours of Cabbage proper; *var.* ***caulorapa***, the Siam Cabbage or *kohl-rabi*; lastly, *var.* ***chinensis***, the "Leaf-boot" or China Cabbage. [*Cf Kew Bull.*, 1888, 137-8; 1893, 344.]

Indian Established Vegetables.

The cabbage (*kobi*), cauliflower (*phul-kobi*), and the turnip-rooted cabbage (*knol-khol* or *kohl-rabi*) have recently become established vegetables and are grown by the market gardeners in the suburbs of all large towns. Except with the Native gentlemen, however, they are not grown in the average village garden, and are not as yet eaten by the mass of the population. A large coarse form of cabbage is extensively cultivated and has become perfectly acclimatised; the early cabbages met with in the markets are the young heads of that plant. The *knol-khol* is relatively more extensively grown in India than in Europe, and seems to succeed admirably in the cold season, if liberally watered for the first fortnight of its growth. There are two kinds commonly seen, a purple and a green, and both are much appreciated: they come into season before almost any other European vegetable. The Chinese cabbage is a rainy-season vegetable, but notwithstanding its being procurable when few other vegetables are to be had, it is not popular in India. [*Cf.* Engler and Prantl., *Pflanzenfam.*, iii. (2), 177-8.]

B. rugosa, *Prain., l.c.* 11-6, 47; *Sinapis rugosa, Roxb., Fl. Ind.*, iii., 122; *B. chinensis, Duthie & Fuller* (*non Linn.*), *Field and Garden Crops*, pt. ii., 34. The Cabbage-leaved Mustard, *pasai* or *pahari-rai*.

Although this plant is closely allied to ***B. juncea*** it is quite distinct. None of the leaves are exactly lyrately lobed, and the radical ones are persistent. It is a cold-weather crop of the Western, Central and Eastern Himalaya, especially in Nepal and Kumaon. It possesses a very short stock till it sets to flower. The permanent radical leaves form a loose cabbage-like head often mistaken for China Cabbage. Prain believes this plant came to India from China, like ***B. juncea***, but in its present form. He, however, recognises as a wild condition of the same stock the Manipur plant discovered and named by me provisionally as ***B. dentata***.

Microscopical Examination.

Kinzel (*l.c.* 115-7) remarks, "As this is the only Indian species (so far, at least, as the material at the writer's disposal has gone) which possesses a cellular separable mucous epidermis, the identification of these fragments of testa in Indian oil-seed with ***B. rugosa*** is, at all events, a fairly probable one owing to the further similarity of their structure in surface preparations." The full description and also the plates given by Kinzel should be consulted by those who may have occasion to identify this or other Indian mustards by the appearance of the seeds. The sample of ***B. rugosa*** examined by him came from Yield of Oil. Kalimpong, and was found to contain 0·826 of mustard-oil.

B. rugosa, *var.* **cuneifolia,** *Prain, l.c.* 14; *Sinapis cuneifolia, Roxb., Fl. Ind.*, iii., 121.

This plant is extensively cultivated in Northern Bengal and Assam as a sage or pot-herb. In my article on ***Bœhmeria nivea*** (*Agri. Ledg.*, 1898, No. 15,

518) I have referred to it as one of the rather remarkable vegetables prevalent within, and hardly met with outside, the rhea-fibre area of India. It occurs, for example, in Dinajpur, Bogra, Rangpur, Kuch Bihár, and throughout the valley of Assam. In nearly every peasant garden a row or two of this plant may be seen. It has a rosette of ground-leaves generally of a dark bluish-green colour and with very broad yellow mid-ribs and leaf-stalks. When young it looks like a cabbage, but in time it shoots up a much-branched inflorescence to a height of four to six feet. This becomes clothed with numerous sessile leaves. All the parts are eaten, more especially the young flowering shoots with their delicate leaves. It is one of the most significant of vegetables, and there are probably several easily recognised forms. It is known, throughout the area indicated, as *lai-hak* or mustard-vegetable. This, with the previous species, would appear to be the only cabbage-like vegetable that existed in India prior to the introduction of the cabbage and cauliflower.

A Vegetable seen in Assam.

THE OILS AND OILCAKES OF MUSTARD AND RAPE.

D.E.P., i., 525-33; v., 470-2.

Oil and Oilcakes.

In the foregoing observations mention has been made of the OILS obtained from the various species of ***Brassica*** and ***Eruca.*** It seems desirable to bring into a separate paragraph a few of the more striking characteristics of these oils and their oilcakes. All the species afford a bland or fixed oil in addition to a volatile or essential oil (Gildemeister and Hoffmann, *Volatile Oils* (Engl. transl.), 1900, 182, 409-17). The essential oil is practically not known to the people of India, so that when mustard, rape or sarson oils are mentioned (by popular writers) it should invariably be accepted that they are alluding to the fixed or fatty oils. The peculiar properties of the essential oil are those on which the merit of a mustard seed mainly depends. It is on this account, therefore, that the researches of Kinzel are of such special interest to India. The passages already quoted from his report give an estimate of the percentage of mustard-oil (a term used in Europe to denote the essential oil only) present in the samples examined by him. Previous reports on the presence of this oil, in the various qualities of Indian rape and mustard, have been unsatisfactory because not definite; they have accordingly retarded foreign exports. Schimmel & Co. give the following as the percentage of mustard-oil in the samples examined by them:—Russian seed, 0·4 to 0·5; Dutch, 0·7 to 0·8; Italian, 0·6 to 0·7; East Indian, 0·6 to 0·7; German, 0·7. Kinzel gives the average yield of *tori* seed as 0·549, *rai* seed 0·814, and *sarson* 0·708 per cent. (*Agri. Ledg.*, 1901, 104.) The pungency of the Indian is thus not so very different from the corresponding European seeds.

Percentage of Mustard-oil.

Pungency.

Cooking-oil.

The *karwa-tel* (= bitter oil) is the fatty oil obtained from Indian mustard and rape seed, and inferior qualities from *sarson.* It is the chief oil used in Indian cookery, and is accordingly very important to the people. Rape (and sometimes also *sarson*) is in India largely used to anoint the body. The practice seems to be fairly ancient, since it is alluded to by Terry (*Voy. East Ind.* (ed. Havers), 1665, 377) as follows:—"The better sort anoint themselves very much with sweet oyls, which makes their company very savory." Rape and *sarson* (*colza*) are names which unfortunately have come to be used almost synonymously by Indian commercial men, and are so treated in official statistics. Nevertheless the fatty oils derived from them are even more distinct from each other than are those from the corresponding European plants. In the *Kew Report* (1877, 34; *Kew Bull.*, 1894, 96-7) we read that the Indian seed known as "Gujarat Rape," largely crushed at Dantzic, is found to yield 3½ per cent. more oil than the European seed, and leaves a cake

"Gujarat Rape."

Rape and Mustard Oils.

Various Qualities.

Presence of the Essential Oil.

Chemistry.

richer in fatty matter and albuminoids. That information was derived from a paper by Dr. Wittmack of Berlin. But the presence of a percentage of the essential oil of mustard in rape-cake has been said to render such injurious to cattle. Roxburgh regarded Indian mustard-oil (fatty oil) as inferior to rape-oil. Duthie and Fuller hold the same opinion. Speaking of mustard-oil, they say it is less esteemed as an article of food than that of rape. Most other writers affirm, however, that although the yield from mustard is less, the quality of the oil is superior to that of either rape or *sarson*. Thus it seems probable that the qualities of rape and mustard vary considerably. *Sarson* is, as a rule, spoken of as an oil that rapidly turns rancid and even for burning purposes has to be purified before it can be used. The mustard-oil of the bazárs of India has a pungent odour and bitter taste, due to the presence of a certain amount of the essential oil. This is occasioned through the habit of watering the cake before pressing it a second time in order to abstract the residuary oil. It is often largely adulterated with poppy-seed and other oils. Dunstan in his paper on Indian Edible Oils (*Agri. Ledg.*, 1899, No. 12) unfortunately affords no information on the comparative values of the Indian mustards and rapes. He furnishes, however, most useful particulars as to their specific gravity, acid value, saponification, viscosity, etc., etc., and classes them as semi-drying oils. Leather in a paper on Food-Grains and Fodders of India (*Agri. Ledg.*, 1903, No. 7) gives further details of the chemical compositions of these oils. Lastly the *Pharmacographia Indica* furnishes all necessary information on the medicinal merits of four qualities. These appear to be Indian mustard, rape, *sarson* and *jamba* (*Eruca sativa*).

The adulteration of linseed with certain qualities of mustard or rape seed has been reported to prove very injurious to cattle fed on such cakes. This subject has been dealt with very fully in the *Dictionary*, and the article in that work on Oils and Oilcakes should therefore be consulted. [*Cf.* Leather, *Agri. Ledg.*, 1897, No. 8, 158; also see **Linum**, p. 731, and **Manures**, p. 770.]

Trade.

PRODUCTION OF AND TRADE IN MUSTARD AND RAPE.

Acreage Subject to Fluctuations.

Acreage.—It has been shown that owing to many of the crops indicated above being grown in conjunction with other plants, it is difficult if not impossible, in our present state of knowledge, to give any very satisfactory statement of the area that they annually occupy. The suggestion has been hazarded that the total (expressed as pure crops) cannot be far short of 5 or 6 million acres. But according to the *Agricultural Statistics* published by the Government of India, both the area and the yield vary considerably, especially in the Panjáb, Rajputana and Sind, in response to the amount and seasonableness of the rains. For example, the Panjáb acreage of these crops, returned in the official statistics of area and yield, was in 1899–1900, 397,500; in the following year, 1,638,400; in the next year, 665,800; and again in 1903–4, 1,038,900, since when it has remained fairly stationary.

Production.

Yield.—Turning now to the estimated production, it would seem that during the ten years ending 1901 there were two periods of abnormal yield, namely 1897–8 and 1900–1. If these be disregarded, the traffic fluctuated from a little over half a million to close on one million tons of seed, during the decade mentioned, and production has shown on the whole a tendency to expand. This view is in strict accord with the constantly repeated statements of popular writers that the trade in these oil-seeds has been steadily increasing, and is now one of the staples of Indian commerce.

Traffic in Rape.
Rail Traffic.

Rape and Mustard Seed: *Rail-borne and Coastwise Traffic.*—The returns of Rape and Mustard carried by rail and river show the exporting provinces to be the United Provinces, Bengal, the Panjáb, Assam and Bombay, in the order named. But as illustrative of the fluctuating nature of the trade, it may be mentioned that in 1897–8 Bengal exported a little under 2 million cwt., the United Provinces close on 1½ million, Assam about ¾ million, and the Panjáb ½ a million cwt. of these seeds. The following year the figures were—United Provinces 2½ million, the Panjáb 1½ million, Bengal 1¼ million, and Assam a little over ¼ million cwt. But by 1906–7 a complete change had taken place—the United Provinces exported 2¼ million cwt., the Panjáb 1 million, Bengal ¾ of a million, and Assam under ¼ million cwt. Calcutta usually heads the list of importing towns, but Bombay and Karachi take the lead in years of high production in the Panjáb. The importance of Karachi as a distributing centre has been established for many years past, and, although extreme fluctuations have been experienced, it can be said to be improving. The following were the supplies conveyed to the chief seaports in 1906–7 :—Calcutta 2¼ million cwt., Bombay 1½ million, and Karachi ½ a million. The coastwise returns show Bengal as the most important province. But for some years the Bengal supply seems to have been falling off, and that of Sind correspondingly expanding. But here again the trade seems to fluctuate so violently that no reliance can be placed on comparisons of short periods.

Coastwise Trade.

Exports.

Exports.—The foreign exports of Rape from India in 1891–2 were 130,793 tons, valued at Rs. 1,76,89,524 ; in 1893–4, 365,954 tons or Rs. 4,73,45,133 ; in 1895–6, 112,489 tons or Rs. 1,40,09,294 ; but they fell in 1900–1 to 86,368 tons or Rs. 1,23,57,451 ; recovered in 1901–2, viz. 346,244 tons or Rs. 4,45,56,044 ; and fell again in 1902–3 to 196,345 tons or Rs. 2,47,11,358. Since then the values of the exports have been—1903–4, Rs. 2,53,41,010 ; 1904–5, Rs. 2,73,37,732 ; 1906–7, Rs. 2,46,70,617. Of the exports the chief receiving countries are Belgium, France, Germany and the United Kingdom.

Traffic in Mustard.

The Mustard traffic is much smaller than that in Rape. In 1891–2 the exports were 2,640 tons, valued at Rs. 3,86,818 ; in 1894–5, 7,809 tons or Rs. 11,27,605 ; in 1900–1 they fell to 1,721 tons or Rs. 3,25,589 ; in 1901–2 they were 3,232 tons or Rs. 5,61,895 ; and in 1902–3 stood at 2,613 tons valued at Rs. 4,93,342. Since then the annual values have been—1903–4, Rs. 4,22,123 ; 1904–5, Rs. 6,19,004 ; 1905–6, Rs. 8,94,553 ; 1906–7, Rs. 5,65,000. Of these exports by far the most important receiving countries in recent years are France, followed by Belgium, Germany, Ceylon, Mauritius and the United Kingdom, the names being given in sequence of importance.

Exports.

Mustard and Rape Oil.—The traffic in Mustard and Rape Oil shows a more steady expansion than that of the seed. In 1899–1900 the exports stood at 259,661 gallons, valued at Rs. 3,52,962 ; in 1900–1 at 283,270 gallons, valued at Rs. 4,70,161 ; in 1901–2 at 286,169 gallons, valued at Rs. 4,74,028 ; in 1902–3 at 314,792 gallons, valued at Rs. 4,79,649 ; in 1903–4 at 346,174 gallons, valued at Rs. 4,84,835 ; in 1904–5 at 432,752 gallons, valued at Rs. 5,58,762 ; in 1906–7 at 273,684 gallons, valued at Rs. 4,90,893. The bulk is exported from Calcutta.

Out of the last year's total (1906–7), 257,282 gallons went from Bengal; 14,244 gallons from Sind; and 2,158 gallons from Bombay. The receiving countries were Mauritius, 113,068 gallons; Natal, 93,787 gallons; United Kingdom, 19,892 gallons; Australia, 22,581 gallons; Straits Settlements, 10,159 gallons; and British Guiana, 3,574 gallons.

Consigned to.

D.E.P., i., 538-41; vi., pt. i., 107.

Paper-Mulberry.

BROUSSONETIA PAPYRIFERA, *Vent.*; *Fl. Br. Ind.*, v., 490; Gamble, *Man. Ind. Timbs.*, 633; Brandis, *Ind. Trees*, 613; Engler and Prantl, *Pflanzenfam.*, 1889, iii., pt. i., 76; URTICACEÆ. The Paper-mulberry or Tapa-cloth, *malaing*, *thale*, *kodzo*, *kaji*, etc. A small tree or bush, native of China and said to be wild on the hills of Upper Burma and Martaban. Frequently cultivated in India, largely so in the Southern Shan States (Craddock), and distributed to Siam, Japan, etc., Western China, Ichang and Yunnan, etc. According to Wiesner (quoted in Stein's *Ancient Khotan*) it is the paper material of Eastern Turkestan; it was introduced into Southern Europe and parts of Germany about 1750. Brandis remarks that it is a marvellous instance of a plant that may be sown both in temperate and tropical countries.

Fibre.

Paper Material.

From the bark of this tree is obtained a FIBRE which perhaps deserves to be carefully investigated. From it is made the falsely named Chinese "leather-paper," the Japanese *kodzo*-paper, the curious papier-maché school-slates of the Burmese (*parabaik*), the *tapa*-cloth of the South-Sea Islands and the mulberry paper cloth of the Karens. It is an excellent paper-fibre, though according to some authorities the stock is a little difficult to prepare of good colour. The silkworm can be fed upon the leaves, and the annual prunings of twigs to obtain a fresh flush for the silkworm might be made to give a profitable return as a paper-fibre. The plant produces suckers in profusion, coppices well and grows fast. It has been most successfully cultivated at Dehra Dun, but the district is too far from the paper-factories to allow of profitable production. It will not survive on jungle-land or on dry soils, nor can it stand severe cold; but it might pay on waste land near the coasts of Bengal, Burma, Malabar, etc., whence transport would be cheap. The usual Japanese method of propagating is by slips. Kæmpfer, followed by Rein, says that every autumn after the leaves have fallen the young shoots near the ground are cut off, and in this way, after three or four years, bushes with from four to seven one-year shoots are obtained. It is estimated that 2 cwt. of raw ***Broussonetia*** bark will yield about 3½ qrs. of white bast—about 45 per cent. Craddock describes the manufacture pursued in the southern Shan States. It closely resembles the description quoted in the *Dictionary* from Royle (*Fibrous Pl. Ind.*, 1855, 341–2). Rein (*Indust. Japan*, 1889, 165, 393–5, 401, 403) gives an interesting account of the plant and furnishes an illustration printed on *kodzo*-paper. (See **Daphne**, pp. 486–7; **Paper and Paper Materials**, pp. 862–4.)

Cultivation.

Yield.

[*Cf.* Stein, *Ancient Khotan*, 1907, 135; Kæmpfer, *Hist. Imp. Jap.* (app.), 1727, 21–7; Mason, *Burma and Its People*, 1860, 522, 775; Fortune, *Yedo and Pekin*, 1863, 122; Baden-Powell, in *Journ. Soc. Arts*, 1886, 709; Hosie, *Three Years in W. China*, 1890, 153; *Corean Paper-making*, in *Ind. For.*, 1893, xix., 199; Morris, *Cantor Lect.*, *Journ. Soc. Arts*, 1895, 938; R.E.P., *Comm. Circ.* 1895, No. 7; Dodge, *Useful Fibre Plants of the World*, 1897, 98–101; Bretschneider, *Europ. Bot. Disc. China*, 1898, 4, 54, 495, 763, 770, 773, 993; *Dipl. and Cons. Repts.* (ann. ser.), 1900, v., No. 2511, 7–9; Craddock, in *Ind. For.*, Dec. 1900, xxvi., 613; Nisbet, *Burma Under Brit. Rule and Before*, 1901, i., 386; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 445–7; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 92–4.]

D.E.P., iii., 341-2.

Brushes.

BRUSHES AND BROOMS, Brush-making Materials, etc.; *Spons' Encycl.*, 1880, ii., 543–57; Jackson, *Comm. Bot., etc.*, 1890; Thurston, *Imp. Inst. Handbook*, 1893, No. 12; Morris, *Comm. Fibres*, *Cantor Lect.* 1895; Hannan, *Text. Fibres of Comm.*, 1902, 141–65.

Brooms are made all over India from a wide assortment of materials presently to be enumerated, the selection being as a rule governed by the supply available and the necessities of the people. Stein (*Ancient Khotan*, 1907, 333) figures and describes what is very possibly the most ancient specimen in existence. This was found at Dandán-Uiliq (a city abandoned in the 8th century). The lower portions of some grass were seen to have been plaited into a continuous strip, then rolled round and secured firmly by a string, thus forming a broom, which in every detail agrees with the corresponding article of modern India.

Indian-made brushes are principally of the bazár-type and are, therefore, mainly of local interest. Two firms, the "Pioneer Army Brush Co." of Cawnpore, and "Messrs. P. Thompson" of Coonoor, Madras, manufacture brushes of the European pattern. Both firms gave some prominence a few years ago to the use of *kittul*-fibre (***Caryota urens***) in place of bristles, from the belief that the *sowars* or Native cavalry would prefer vegetable fibre to animal bristles. Although Indian-made brushes may now be seen all over India, particulars are not available of the actual extent of manufacture. There is moreover a very considerable import by India from Europe of brushes, but complete statistics are not available. We read, for example, that from the United Kingdom there were received in 1903, 2,891 dozen brushes valued at £8,910.

Materials.—Turning now to the materials used. It would be undesirable to attempt a complete enumeration of all the substances which in India are employed, or which might be so, for brushes or brooms. Even in Europe the variety and diversity are extraordinary—*e.g.* bristles, *kittul*, broom, rattan, whalebone, wood, rushes, wire, spun-glass (specially serviceable for contact with acids), etc., etc. India at the same time exports a very considerable quantity of brush-making materials including both vegetable fibres and bristles, and the trade would appear to be improving. Thus in 1899–1900 the total exports were 54,388 cwt., valued at Rs. 11,49,998; whereas in 1903–4 they were 83,258 cwt., valued at Rs. 20,76,331; and in 1906–7, 88,158 cwt., valued at Rs. 17,68,930. Although in point of quantity Madras takes by far the largest share, viz. 79,350 cwt. in 1903–4 and 85,203 cwt. in 1906–7, the goods it exports are much lower priced (viz. Rs. 9,70,328 in 1903–4 and Rs. 9,71,212 in 1906–7) than those sent from Bengal (viz. 3,296 cwt., valued at Rs. 9,60,571 in 1903–4, and 2,360 cwt., valued at Rs. 6,52,827, in 1906–7). The Bengal exports are mainly in high-priced bristles. Of these Bengal exports for 1903, Rs. 5,75,790 represented the value of the bristles sent to England, whilst only Rs. 22,470 were attributable to vegetable brush-fibres with the same destination. The total exports of brush-making materials from all India to Great Britain in 1903 were 17,943 cwt., valued at Rs. 10,38,909, and of that amount Rs. 6,07,305 was the value of the Indian contribution of bristles to the British supply.

Exports.

Bristles.

The following are some of the principal plants employed in brush-making:—

Arenga saccharifera, *Labill.* (see p. 92).

Aristida setacea, *Retz.*; *Fl. Br. Ind.*, vii., 225; GRAMINEÆ. Broomstick-grass, *shipur-gaddi*, *vina-pullalu*, *thodapga-pullu*, etc. A reed three to four feet in height, found in Western India from Bihár and the Konkan southward, also in Ceylon, the Mascarene Islands, etc. The roots attain a length of 15 inches to 3 feet and are said to be used in the manufacture of weavers' brushes in Madras and along the west coast (*Ind. Agri.*, Dec. 12, 1891). These roots are collected in South India by Yerukalas (a nomad tribe) and sold to the weavers at 3 or 4 annas a viss. The Telinga paper-makers construct their frames of the

D.E.P., i., 312.

culms and these are also employed for making *tatties* in the same way as the *khas-khas* roots of Northern India.

Agave Cantala, *Roxb.*, and other species (see p. 33).

Bambusa, various species (see pp. 99–101).

Borassus flabellifer, *Linn.* (see p. 170).

Bristles, see **Live Stock (Hogs)** (p. 752).

Caryota urens, *Linn.* (see p. 286).

Chloroxylon Swietenia, *D.C.* (backs of brushes) (see p. 294).

D.E.P., ii., 274.

Chrysopogon Gryllus, *Trin.* The roots of this plant are said by Jackson, Hannan and others to be the Venetian whisk-fibre which in England and other countries is made into brushes of various kinds. The grass is abundant on the hills of North India, but except as a fodder plant it is apparently not known to be of any economic value.

Cocos nucifera, *Linn.* (see p. 356).

Corypha umbraculifera, *Linn.* (see p. 429).

D.E.P., iv., 198.

Hair of bears, squirrels, camels, badgers, goats, polecats, sables, ichneumons, etc., is used in the European brush industry, but no information is available as to the extent, if any, to which India contributes to the supply, or herself utilises any of the hairs mentioned.

Ischæmum angustifolium, *Hack.* (see p. 694).

D.E.P., vi., pt. i., 5 6.

Pandanus odoratissimus, *Linn., f.*; the Screw-pine—the *keura, ketgi, kenda, talum, mugalí*, etc. A common and much-branched plant frequently grown on account of the fragrance of its flowers, but is wild on the coasts of South India, Burma and the Andaman Islands. The leaves contain a strong fibre used for cordage and for spinning into coarse yarn. The roots are used in basket and brush-making (**Perfumery**, see p. 821). [*Cf.* Forster, *Pl. Esc.*, 1786, 38–41; *Rept. Ind. Hemp Drugs Comm.*, 1894, i., 156; Marco Polo, *Travels*, ii., 250; *Ain-i-Akbari* (Jarrett, transl.), ii., 126; etc.]

Phœnix sylvestris, *Roxb.* (see pp. 115, 884 5).

Saccharum arundinaceum, *Retz.* (see p. 930).

Sorghum vulgare, *Pers.* the Italian whisk (see p. 1031).

Tamarix, *spp.*, see **Baskets** (p. 116).

Vetiveria zizanioides (see p. 1106).

D.E.P., i., 544 5. Piyar.

BUCHANANIA LATIFOLIA, *Roxb.*, *Hort. Beng.*, 1814, 32; *B. Lanzan*, *Spreng.*, in *Schrader Journ.*, 1801, v., 4; Cooke, *Fl. Pres. Bomb.*, i., 275; *Fl. Br. Ind.*, ii., 23; Gamble, *Man. Ind. Timbs.*, 216; *Pharmacog. Ind.*, i., 394; *Agri. Ledg.*, 1899, No. 12; 1900, No. 9; Duthie, *Fl. Upper Gang. Plain*, i., 185; Brandis, *Ind Trees*, 205; ANACARDIACEÆ. The *piyar, chironji, pial* or *peal, chirauli, paira, tarum, char-ka-gond, mowda, nuskul, lonepho*, etc., etc. A middle-sized tree, leafless only for a short time, met with in the dry forests throughout India and Burma, ascending in the Sub-Himalayan tract to 3,000 feet, and frequently associated with the *sál*, the *mahúa* and the *dhák*.

Gum.

A pellucid GUM (*peal* or *pial*) which exudes from wounds in the stem is more than half soluble in water. It is said to resemble Bassora gum, to have adhesive properties like inferior gum arabic, and to be suitable for dressing textiles. As a consequence of inquiries organised by the Reporter on Economic Products it was found that in many provinces the gum is not collected, while it is reported from Jhansi (U. Prov.) as used in printing cloth, from Berár as employed in dyeing, and from the Central Provinces as sold mixed with *dhawra* gum (***Anogeissus latifolia***) to the *banias*. On some samples sent to the Imperial Institute, London, the Director reported that the gum was not entirely soluble, but when mixed with twice its weight of water, about 10 per cent. formed a gelatinous mass; the sample examined, moreover, contained a large quantity of extraneous matter. The brokers reported that if it were carefully collected and a regular supply ensured, it might fetch 20*s.* per cwt. on the London market, and be employed for cheap manufacturing purposes. [*Cf. Agri. Ledg.*, 1900, No. 9, 92.]

Varnish. Oil. Nuts.

The bark and the fruits furnish a natural VARNISH. The kernels yield a sweet and wholesome OIL (*chironji*), but owing to their being much prized as a sweetmeat when cooked, the oil is seldom expressed. The kernels, which have a flavour something between that of the pistachio and the almond, are eaten by

Fodder.
Timber.

the Natives (Baber, *Memoirs*, 1519, (Engl. ed.), 326). They are also used to flavour *ganja* (*Rept. Ind. Hemp Drugs Comm.*, 1894, 157). In the hills of Central India the fruits with the kernels are pounded and dried and subsequently baked into a sort of bread (Church, *Food-Grains of Ind.*, 177). From the Panjáb and Bombay the leaves are reported as used for FODDER. The TIMBER is not very hard nor durable and is of small value, though made into spoons, plates, toys and bedsteads, and is even employed for door and window frames, plough-handles, etc. White insect-wax has been found on the tree in the Central Provinces. The kernels of ***B. angustifolia**, Roxb.*, are used like those of the above species. [*Cf. Ain-i-Akbari* (Blochmann, transl.), 1590, 71; *Taleef Shereef* (Playfair, transl.), 1833, 68; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 161; Lisboa, *Useful Pl. Bomb.*, 1884, 53–4, 217, etc.; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 128–9; *Journ. Soc. Chem. Indust.*, xi., 404; *Ind. For.*, Sept. 1895, xxi., 329; Biscoe, *Hyderabad Trees*, 1895, 3; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 53; *Rept. Coll. Ind. Mus. Calc.*, 1901, 61; etc., etc.]

D.E.P., i., 548-56.
Palas.

BUTEA FRONDOSA, *Roxb.*: *Fl. Br. Ind.*, ii., 194; Roxburgh, *As. Res.*, 1792, iii., 469–74; Jones, *As. Res.*, 1795, iv., 299–300; Buch.-Ham., *Stat. Acc. Dinaj.*, 159; Solly, *Journ. Roy. As. Soc.*, vii., 145; Heuzé, *Les. Pl. Indust.*, 1895, iv., 293; Gamble, *Man. Ind. Timbs.*, 243–4; *Pharmacog. Ind.*, i., 454–8; Cooke, *Fl. Pres. Bomb.*, i., 371; Duthie, *Fl. Upper Gang. Plain*, i., 240; Brandis, *Ind. Trees*, 230; LEGUMINOSÆ. The Butea Gum, Bengal Kino, or Bastard Teak, *dhák, palás, chichra, murúp, parás, khákra, multuga, pauk*, etc. From *palás* is said to be derived Plassey (*palási*), the scene of Clive's victory. A moderate-sized deciduous tree common throughout the plains of India and Burma, and ascending the hills to about 4,000 feet in altitude.

Gum.
Medicine.

This well-known tree is, when in flower, a conspicuous feature of open country and grass lands, owing to its brilliant flowers which appear at the beginning of the hot season. It is valuable for recovering salt-lands since it will grow even where there is a bad efflorescence of *réh* (see **Alkalis and Alkaline Earths**—**Réh**, p. 55). It yields naturally, or from artificial scars on the bark, a GUM called *chúniá-gónd, kamarkas, palás-ki-gond*, etc., which occurs in round tears, as large as a pea, of an intense ruby colour and astringent taste. The gum is used in Native MEDICINE as a substitute for true kino (***Pterocarpus Marsupium***, which see, p. 908). Roxburgh pointed out that it differed from true kino in being more soluble and the solution more astringent in water than in spirit, just the reverse being the case with the product of ***Pterocarpus***. A great deal has been written on the subject in chemical and pharmaceutical journals and other publications. Hooper, for example, has dealt with it at length in the *Pharmaceutical Journal* (June 23, 1900, 4th ser., x., 664 *et seq.*).

Lac.
Dye and Tan.

The gum is usually very impure owing to careless collection, and it would be a matter of some difficulty to clean it for medicinal purposes. In any case with true kino available in India, in sufficient quantity to meet all medical requirements, there is not likely to be any market for this substitute. The Lac insect (p. 1053) is reared upon the tree in India, and it is regarded as affording the second best quality. [*Cf. Tachardia lacca, Agri. Ledg.*, 1901, No. 9, 181, 211, 221, 224, 230–1, 235, 238–9, 242, 250, etc., etc.] The gum may be used both as a DYE and TAN, but for these purposes is hardly, if at all, in demand outside India. The Natives are said to use it to purify and precipitate blue indigo. It seems possible that if the bark or wood were utilised as in preparing ***Catechu***, a pure tanning extract might be obtained. The flowers, called *tésú, késú*, etc., yield a brilliant yellow dye by simple decoction, but the colour is fleeting, though rendered a little less so by the addition of an alkali. Formerly it was much used at the *Hóli* festival, the fleeting character being regarded as an advantage, but at the present time it appears to have lost its popularity, being supplanted by aniline dyes. Hummel and Perkin (*Journ. Soc. Chem. Indust.*, 1895, xiv., 459–60) point out that under certain treatment the colours given by ***Butea*** flowers resemble those afforded by young fustic. Hence these chemists add that they "cannot therefore endorse Sir Thomas Wardle's opinion that if ***Butea*** flowers could be obtained in sufficient quantity and sufficiently cheap they would be a useful addition to the yellow dyes we already possess" (see p. 1053). Fibre. The bark yields a FIBRE used for rough cordage and for caulking boats. Oil. A bright, clear OIL derived in small quantity from the seeds (*palás-páprá*) is Medicinal. used in MEDICINE. Dymock (*Mat. Med. W. Ind.*, 1885, 232) says, "I have tried the seeds as an anthelmintic and am inclined to think favourably of them: they have an aperient action." Pounded with lemon-juice they are a powerful rubefacient, and have been known to cure herpes. ***B. superba***, *Roxb.*, is considered to possess similar properties to those of ***B. frondosa***. [*Cf.* also *Rept. Cent. Indig. Drugs. Comm.*, i., 45, 65, 81, 121, 180, 282.] The leaves Fodder. are given as FODDER to buffaloes. Timber. The TIMBER is not durable above ground, but is said to be much better under water, and is consequently used in Upper India for well-curbs and piles and also for the water-scoops of Native wells. Gamble observes that if cut up green and seasoned in the plank, it is likely to be a fair wood for rough boxes. Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 159) says that the flowers are offered to the gods. [*Cf. Journ. As. Soc.*, 1813, iii., 219–20; *Taleef Shereef* (Playfair, transl.), 1833, 40; Taylor, *Topog. Stat. Dacca*, 1840, 62; Wardle, *Rept. Dyes and Tans, Ind.*, 1887, 7, 20, 36–8, 51; Forsyth, *Highlands Cent. Ind.*, 1889, 380, 421, 463; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 53–4; *Gaz. Karnal Dist. Pb.* (2nd ed.), 1890, 18–9; Russell, *Monog. Dyesing Indust. C. Prov.*, 1896, 17; Hooper, *Rept. Labor. Ind. Mus.* (Econ. Sec.), 1900-1, 17; Joret, *Les. Pl. dans L'Antiq., etc.*, 1904, ii., 347, etc.]

D.E.P., i., 556 9. Boxwood. **BUXUS SEMPERVIRENS,** ***Linn.***; *Fl. Br. Ind.*, v., 267; Gamble, *Man. Ind. Timbs.*, 592–4; Brandis, *Ind. Trees*, 1906, 559; EUPHORBIACEÆ. The Boxwood Tree, *shanda laghúne, chikri, papri, shamshad, shumaj, shibsashin*, etc., etc. An evergreen shrub or small tree of the Suliman and Salt Ranges, the Himalaya eastward to Nepal and Bhutan (absent from Sikkim), at 4,000 to 8,000 feet, chiefly in shady ravines, more especially on calcareous soils. It is a slow-growing tree, very difficult to raise from seed.

Medicine. A tincture from the bark is used in MEDICINE as a febrifuge, and the leaves are occasionally browsed by goats, though to most animals they are poisonous. Boxwood is found on the Himalaya of large size, occasionally over 5 feet in Timber. girth, 3 feet being not unusual. The TIMBER is very valuable, being in great demand for turnery, carving and other purposes for which a very hard, close-grained wood is required. The principal European use, since the 15th century, has been for wood-engraving, and it is regarded as the best substitute for ivory in many ornamental purposes. But the Indian areas are almost always difficult of access, and it has been found that the timber cannot be cut, seasoned and delivered at an Indian port, still less in London, at the prices usually offered. Hitherto the principal supplies for Europe have come from the Caucasus, but this is spoken of as being rapidly exhausted. The trade has accordingly asked for suitable substitutes that may at least meet certain of the purposes of boxwood. The following have been mentioned as the more likely Indian timbers:—

Boxwood Substitutes.

Atalantia monophylla.
Celastrus spinosus.
Chloroxylon Swietenia.
Cratægus Oxyacantha.
Dodonæa viscosa.
Euonymus Hamiltonianus.
Gardenia latifolia.
Hemicyclia sepiaria.
Ixora parviflora.
Lasiococca symphylliæfolia.
Murraya exotica.
Olea ferruginea.
Psidium Guyava.
Punica Granatum.
Santalum album.
Viburnum erubescens.
Wrightia tinctoria.

C

D.E.P., ii., 3 6. Bonduc. **CÆSALPINIA BONDUCELLA,** ***Flem.***, *As. Res.*, 1810, xi., 519; *Caretti* in Rheede, *Hort. Mal.*, ii., t. 22; *Globuli majores* in Rumphius, *Herb Amb.*, v., 92, t. 49, f. 1; Bentley and Trimen, *Med. Plants*, ii., t. 85; Duthie, *Fl. Upper Gang. Plain*, 1903, i., 302; *Fl. Br. Ind.*, ii., 254; LEGUMINOSÆ. The Fever-nut, the Nicker-tree (*Yeux de bourrique*, Fr.); *putikaranja, kat-karang, karaung, náta, kanja, gach-chakaya, gila, gajkai,* *kalachi*, *gajji*, *kákachia*, *sagargota*, *gájarghota*, *kalein*, etc. *C. Bonduc*, *Roxb.*, is perhaps only a variety of *C. Bonducella*. The properties of the two plants are identical, but the seeds of the former are brown-coloured (not steel-grey) and, owing to only one being usually in the pods, are not angled. The name *bonduc* was probably given because of the bullet-like seeds.

A scandent thorny bush found in India and Burma, ascending the hills to altitudes of 2,500 feet and often very gregarious. Frequent as a hedge, planted or self-sown. Is very common near the seashore in most tropical countries, the seeds being carried by the sea without losing their vitality. A littoral species that often forms impenetrable thickets. [*Cf.* Prain, *Bot. Laccadives*, 38.]

Medicine.

Dentrifice.

Oil.

In India the seeds (nuts) are held in high esteem as a MEDICINE used in the treatment of intermittent fever, especially if associated with skin disease. A powder was made officinal in the Indian Pharmacopœia of 1868. It is recommended to be administered along with black pepper in doses of from 5 to 60 grains. It contains a bitter principle that may be separated as a white amorphous substance, through the circumstance that it is soluble in alcohol, chloroform, glacial acetic acid, etc. From its chloroform solution it may be precipitated on being poured into petroleum ether, or from the glacial acetic acid solution on being thrown into water. A writer in *Comptes Rendus* (July 1886) says the medicinal virtue of the cotyledons contained within the seed is due to their bitter extractive principle, the properties of which have not been accurately ascertained. Clinical experiments conducted by Isnard at Marseilles, however, would seem to confirm the Indian reputation of merit as an antiperiodic. Applied externally the powder, made into an ointment with castor oil, is held to be beneficial in hydrocele, and the burnt seeds reduced to a powder are regarded as a valuable DENTIFRICE, especially in spongy gums. The seeds are also said to afford an oil which is employed as a COSMETIC. The leaves and the root-bark are regarded as possessing similar properties to the seed, though weaker. [*Cf.* Hughes, *Nat. Hist. Barbados*, 1750, 195, t. 18 (drawn by G. D. Ehret); Taylor, *Topog. Stat. Dacca*, 1840, 52; Irving, *Topog. Ajmir*, 1841, 192; *Pharmacog. Ind.*, i., 496–9; Rusby, *Druggists' Bull.*, 1890, 323–5; Banerjei, *Agri. Cuttack*, 1893, 187, 196; Dhargalker, *Notes on Therap. Indig. Veg. Drugs*, 1899, 96; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 59, 94, 146, 181, 342; Gamble, *Man. Ind. Timbs.*, 1902, 267; Cooke, *Fl. Pres. Bomb.*, i., 410; Brandis, *Ind. Trees*, 246; Talbot, *List. Trees, etc.* (2nd ed.), 141; etc., etc.]

D.E.P.,
ii., 6 9.
Divi-divi.

C. coriaria, *Willd.*: Warburg, *Der Tropenpflanzer*, 1901, v., 85–8, ff. A, B, C and D; Hooper, *Agri. Ledg.*, 1899, No. 10; Dunstan, *Rept. on Indian-grown Pods*, 18–9. The *divi-divi* or America Sumach (the true Sumach or Sumac is *Rhus Cotinus*).

Acclimatised.

Past Failures.

Climatic Requirements.

A small tree, native of South America and the West Indies. Introduced into India shortly after the appearance of Dr. W. Hamilton's report (1834) on the merits of the pods as a tanning material. It is now fairly extensively grown, if not almost acclimatised in the Western Presidency, especially in Dharwar, Kanara, Bijapur, Bhadgaon (in Khandesh), Belgaum, etc. Also in South India, especially in North Arcot and South Kanara. In Mysore and Coorg it has been tried, and with some success, as a shade-tree for coffee and thus an auxiliary crop. In the United Provinces and in Bengal the tree has hitherto been experimentally cultivated only, and with questionable success. Of Chota Nagpur, for example, one report speaks favourably; a later one explains the want of vigour as owing to the seedlings not having been transplanted; four years later the failure then recorded is attributed to the seedlings having been transplanted; and lastly the plantation is abandoned. This is not the history of all experiments, but imperfect knowledge or want of continuity of knowledge is probably more responsible for the results attained than any other explanation as yet adduced. It is probable, however, that insular conditions might be anticipated to afford better results than continental.

Properties.

Indian-grown Pods.

Hooper reviews all available information but unfortunately does not furnish the results of any special chemical investigations into the varying qualities of the cultivated pods now procurable from the provinces of India, nor into the variations consequent on the seasons of

Tan and Dye.

Qualities of Pods.

Unfavourable Circumstances.

Injurious Fermentation.

Anti-ferment Necessary.

collection and methods of preservation, etc. "*Divi-divi*," he affirms, "is classified by dyers and tanners as a true astringent and is associated with oak-galls and myrobalans in affording a maximum amount of tannin with a minimum amount of colouring matter." Crooke (*Practical Handbook Dyeing and Calico Printing*) speaks of *divi-divi* (or *libi-divi* as it is sometimes called) as being one of the most important astringents in the market. "The best pods," he writes, "are thick and fleshy and of a pale colour. Those which are dark, with black spots and blotches, have probably been gathered in a damp state, or have been subsequently exposed to moisture, which greatly reduces their value. The amount of tannin in *divi-divi* is greater than in sumach or even myrobalans." These opinions had reference of course more especially to the use of *divi-divi* dyeing, and accordingly Crooke adds that a great objection to *divi-divi* lies in the fact that fragments adhere to the textile, which act as resists and produce a mottled condition of the dyed surface. But from the tanner's point of view *divi-divi* is an uncertain material, more especially if the seeds be contained within the pods. It is greatly influenced by atmospheric conditions, is very subject to injurious fermentation, and imparts weight to leather through the absorption of a gummy substance which is less waterproof than the materials imparted to skins by other tans. In India, according to Thorpe (*Madras Mail*, 1888), *divi-divi* cannot be successfully used without the aid of an anti-ferment.

Indian *versus* American Pods.

Varying Qualities.

Hummel (in connection with the Colonial and Indian Exhibition of 1885–6) was the first of the modern chemists to examine the Indian-grown pods. He reported that they were inferior to the American and West-Indian. Proctor (*Leather Indust.*, 1898, 77) gives a classification of tanning materials and shows *divi-divi* along with *Acacia arabica* pods, myrobalans, etc., as a pyrogallol tan. Mr. A. G. Perkins of the Yorkshire College gives the tannin of these pods as ellagitannic acid. Dunstan found an inferiority similar to that reported by Hummel. He had sent to him samples from Chota Nagpur in Bengal, and after examining these expressed the opinion that the pod from other parts of India (Bombay and Madras, etc.) might be found richer in tannin than the Bengal sample. American pods, Dunstan adds, usually contain from 30 to 50 per cent. of tanning matter. The Bengal pods were found to contain only from 19·73 to 32·79 per cent. Warburg discusses the cultivation of *divi-divi* in German East Africa and furnishes particulars of the imports into Hamburg. [*Cf.* Stewart, *Tanning and Currying Leather*, in *Select. Rec. Govt. N.-W. Prov.*, 1870, also revised in Watt's *Select. Rec. Govt. Ind.*, 1889, 100–11; *Ind. Agri.*, March 1882: Cooke, *Fl. Pres. Bomb.*, i., 413; Gamble, *Man. Ind. Timbs.*, 268; Talbot, *List. Trees, etc.* (2nd ed.), 141; *Rec. Bot. Surv. Ind.*, ii. (Plant Chota Nagpur), 99.]

**D.E.P., ii., 9.
Tari Pods.**

C. digyna, *Rottl.*: *Fl. Br. Ind.*, ii., 256; Hooper, *Agri. Ledg.*, 1899, No. 9; 1902, No. 1, 27; Dunstan, *Imp. Inst. Tech. Repts.*, 1903, 192–7; Prain, *Beng. Plants*, i., 1903, 449. It is best known by the following names:—*vakeri*, *vakeri-mal*, *kunti*, *amal-kuchi* (or *kochi*), *núni-gatch*, *gaukungchi*, *sunletthe* (or *sun-let-the*).

First Mentioned.

History.—By what appears to be an error, the pods of this prickly climbing shrub have been called *tari*, *teri*, or *tourhi*. The earliest mention of them would seem to be in an article by Mr. John Teil which quotes two letters from Mr. Sconce of Chittagong, dated April 23 and July 7, 1847, addressed to the Secretary of the Agri.-Horticultural Society of India. In the last letter Mr. Sconce gives them their Chittagong name *jeri* (vi., 246–51 and app., 6–8). It seems probable the true *tari* is *C. Sappan*: in fact *tari* is almost a generic word for tanning material and is applied very frequently to myrobalans. The plant is met with in Central and Eastern Bengal, Assam, the Circars and Burma, and according to Brandis it occurs also in the Central Provinces (Sambulpur) and in the Western Peninsula. Recently it has been experimentally cultivated in many parts of India and even in some foreign countries, the demand for the pods having been very considerable.

Oil.

Tanning Material.

Medicine.

History of Present Inquiry.

Properties and Uses.—Roxburgh named the bush *C. oleosperma* in allusion to the Oil afforded by the seeds, which he tells us was in some parts of the country employed as a lamp oil. He makes no mention of the still more valuable property of the pods as a source of tannic acid. None of the standard works published prior to 1890 make definite references to the use of the pods in medicine or as a tanning material, though Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 170) states that they were in his day much employed by the dyers. It may thus be said that while these pods had been favourably reported on by Mr. John Teil of Calcutta in 1848, they were subsequently forgotten for fully half a century. In 1892 Mr. E. M. Homes, Curator of the Museum of the Pharmaceutical Society of Great Britain, sent to the Reporter on Economic Products some "*tari*" pods that he had received from India as a medicine. He suggested that an inquiry might be instituted into the source and available supply, and accordingly they were identified. *Tari* pods were in consequence included in the programme of operations of the Reporter for 1893. A circular letter was issued to the Directors of Agriculture in Madras, Bengal, Assam and Burma. In 1894 samples came from many districts in Burma. About the same time the Director of Assam (in connection with a monograph on dyes of that province, which he had under preparation) sent a sample of "*teri*" pods to be determined. He was at once informed that they were the pods of *C. digyna* regarding which a special inquiry had been addressed to his office. Holmes had the pods analysed in 1892 (by Messrs. Gonne, Croft & Co.), when they were found to contain 33¼ per cent. of tannin. Shortly after Evans published in "*Leather*" a report in which he mentions a yield of about 33 per cent. Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 844–5), quoting from Hartwich (*Die Neun Arzneidrogen, Pfl.*, 1897, 27) under *Acacia digyna?*' mentions that the pods contain 33·25 per cent. of tan, and, like Holmes, Evans and others, he adds that if procurable in quantity they might come into extensive use. In 1898 a large supply was in consequence procured from Sylhet, from many districts in Burma, and also from Chittagong. But it is remarkable that so far none have been procured from the Circars, where Roxburgh first found the plant.

Supply Available.

No Demand

The Forest Department have taken the greatest possible interest in this new product (consult the late Mr. H. C. Hill's letter of July 20, 1901, to all Conservators of Forests). The Annual Reports from Burma and Bengal record from year to year the progress made. The Report for Tenasserim (1901–2, 27) says, "There is no demand and the stock of 60 bags was sold for Rs. 4 per bag, a price that just covered expenses." The Report for the Southern Circle in 1902–3 states that the plant had proved easy of cultivation, but adds, "As there appear to be no present demands for the pods, further plantations of this species are not wanted." It will thus be seen to rest with the trade to say whether or not the expectations of writers on this subject are to be realised.

High Yield of Tannin.

A fair quantity of two sets of pods, secured through the Forest Department of Burma, and a corresponding parcel from the Assam stock, were consigned to the Imperial Institute, London and in due course reported on by the Director. The two parcels (of pod-cases without the seeds) from Burma were found to contain 53·82 and 53.86 per cent.

Richest of Tanning Materials.

tanning material, while the Assam sample was still richer, viz. 59·89 per cent. The report (*l.c.* 192) continues: "With the view of obtaining a practical opinion as to the tanning value of this powder, a sample was furnished to a well-known tanning expert, who reports that he is much impressed with the results that he has so far obtained; they compare very favourably with those furnished by the best *divi-divi*, whilst the aqueous liquor from *C. digyna* did not appear to undergo the injurious fermentation which is the difficulty in the use of *divi-divi*." A second consignment from Assam was sent to the Imperial Institute in 1900 and found to contain a slightly lower percentage of tannic acid, viz. 45·45 per cent., also a third parcel from Burma, which, however, contained more than the previous, viz. 60·5 per. cent. These results accordingly place the pods among the richest of tanning materials, and they undoubtedly impart an excellent colour to the skins. They are, in fact, much richer in tannic acid than was supposed some few years ago. It may therefore be added that it would be unfortunate (as seems likely) if they should be destined to a second half-century of oblivion, such as followed their original discovery by Mr. Sconce in 1847. [*Cf.* Gamble, *Man. Ind. Timbs.*, 266; Brandis, *Ind. Trees*, 247; *Rec. Bot. Surv. Ind.*, ii. (Plants, Chota Nagpur), 99; Hanausek, *Berichte der Deut. Bot. Gesell.*, 1902, 77 (Gvsh.), (gives a long account of the microscopical structure of the pods); *Board of Trade Journ.*, 1903, i., 146; Chandra, *Tanning, and Working in Leather, Beng.*, 1904, 7; Chatterton, *Tanning, and Working in Leather, Mad. Pres.*, 1904, 47.]

D.E.P., ii., 10-2. Sappan.

History of the Name.

C. Sappan, *Linn.; Tsja-Pangam*, Rheede, *Hort. Mal.*, 1686, vi., t. 2; *Lignum Sappan*, Rumphius, *Herb. Amb.*, 1750, iv., 56–8, t. 21; Roxb., *Corom. Pl.*, i., 17; Beddome, *For. Man.*, 90, pl. xiii., f. 1.; Greshoff, *Nutt. Ind. Pl.*, 1894, 121–4, t. 29; *Fl. Br. Ind.*, ii., 255. The Sappan- or Bakam-wood or Sampfen-wood, sometimes also called Brazilian-wood (the name Brazilian being derived from *braise* (red coals) and thus originally unconnected with the country of that name; in fact, given long prior to the discovery of Brazil). The better known vernaculars of India are—*bakam* (*bokom*), *tairi*, *teri*, *patang*, *pattánga*, *sappanga*, *chapangam*, *tein-nyet*, etc.

Derivation of Sappan.

History.—This plant is frequently mentioned in letters from East India Co.'s servants at the beginning of the 17th century, showing that it was a well-known article of trade even then. One of the earliest detailed descriptions of it, however, is that given by Rheede, where it is called *tsia-pangam*. That account was followed by the *Herbarium Amboinense*, in which a long list of both the European and Native names for it are given, but of these the Bengali *russok* need only be here specially mentioned—a name that does not appear to be in use at the present time since in Bengal it is generally known as *bokom*. It is also interesting to add in this connection that Rumphius suggests the derivation of Sappan from the demand of the Arabs for the wood to be employed in the construction of certain ornamental boats or portions of boats. Hence, adds Rumphius, comes the Malayan *sampan*, a decorated boat. He further tells us that the pegs (or wooden nails) employed in ship-building are chiefly made of this wood. But the Sappan is a small thorny tree of the Eastern and Western Peninsulas of India, also of Pegu, Tenasserim and the Shan plateau of Burma—cultivated where met with elsewhere in India and Burma. Hence with its Malayal name *shappannam* and its Tamil *shappu*, it is more likely, as suggested by Yule and Burnell (*Hobson-Jobson* (ed. Crooke), 794), that the word *sappan* was derived direct from India itself and is not Malayan. Gamble (*Man. Ind. Timbs.*, 1902, 267) says he has never seen it wild. Rheede observes that it prefers sandy places, is indigenous to Travancore and cultivated as an ornamental and useful tree all over Malabar.

Properties and Uses.—The wood yields a valuable red DYE, which, before the days of aniline, was exported very largely from India to Europe. Recently the traffic has declined very materially. But the dye may also be obtained from the pods (*tairi*) and from the bark, hence the necessity of not confusing the pods of this species with those of ***C. digyna***, which are nowadays also called *teri* or *tari*. The accounts given by both Rheede and Rumphius of the methods pursued by the dyers of India or of the East might be given as a modern statement, so very accurate are these writers in most particulars. The use of *lodh* (*leha*) bark (***Symplocos racemosa***, p. 1053) as a dye auxiliary, and of chalk to deepen the colour and of alum to fix it, as also the circumstance that the colour is bleached or destroyed by acetic acid—these and such other circumstances are fully detailed. Rumphius tells us that in preparing the decoction the Natives throw a few grains of paddy into the boiling liquid. If the husk scales off, the boiling is regarded as sufficient, not otherwise.

Auxiliaries.

Boiling.

Sir Thomas Wardle speaks very favourably of sappan in wool-dyeing and in calico-printing. Of the pods, he observes that they are astringent and much used in dyeing and tanning since they produce with salts of iron a rich black. It may be doubtful whether the pods alluded to are, however, those of this plant; they may be those of ***C. digyna.*** Sule, speaking of Berár, describes the manufacture of a special dye called *abashai* from the wood. Giles similarly says that in the Karenni country a plant known as the *sawku* (possibly *sappan*) affords from the powdered root a brick-red dye that on being boiled with cotton becomes permanent and requires no mordant to fix it.

Preparation of Decoction.

Pods.

By the Sanskrit authors *suppan* is often treated as a form or quality of sandal-wood. It is not generally recommended as a medicine either by the Hindus or by the Muhammadans of India, but has for years been employed by Europeans in India as a useful substitute for logwood. [*Cf. Rept. Cent. Indig. Drugs Comm.*, i., 156.] Ainslie speaks of the emmenagogue properties of a decoction of the root.

Medicine.

According to the *Pharmacographia* there are two qualities of the wood met with in Indian shops, viz. the Singapore and the Dhunsari, with a third and less valuable obtained from Ceylon. It sells at from Rs. 30 to Rs. 42 per *kandy* of 7 cwt., according to quality. Fawcett (*Monog. Dyes Bomb.*, 15) calls it by the old name—" Brazilian-wood," and speaks of it as imported from Siam and Malabar. It sells at Rs. 2 per 12 seers (24 lb.) and is largely used in preparing *gulal*. Formerly it was extensively employed in Ahmedabad in cotton-dyeing but has been superseded by aniline, which is sold under the appropriated name of *patanga*. In this connection it may also be remarked that in Lahore I found a yellow aniline sold in packets under the name *piorina* : illustrations of the direct adaptation of the aniline wares to the markets of India, the former being intended to supplant the classic *patang* and the latter the *piori*. [For chemistry *cf. Pharmacog. Ind.*, i., 500; *Journ. Chem. Indust.*, 1898, xvii., 691; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 252, etc.]

Trade Qualities.

Aniline Imitations.

Chemistry.

[*Cf.* Marco Polo, *Travels*, 1290, ii., 312, also n. 315; Varthéma, *Travels*, 1510, 205; Garcia de Orta (though often cited, does not apparently allude to it); Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), 1598, i., 121; Banerjei, *Agri. Cuttack*, 199; *Monographs, Dyes and Dyeing*:—Hadi, 78; Fawcett, 15; Holder, 1896, 2; Banerjei, 1896, 13, 17, 23, app. ii.; J. D. Fraser; F. R. Giles, 4;

H. G. Leveson, 6 ; B. B. Sule, 5 ; *Notes on Dyes by Conserv. For. E. Circ. Burma*, 1896 ; Liotard, Memo. *Dyes*, 24–6 ; Talbot, *List Trees, etc.*, 141 ; *Rec Bot. Surv. Ind.*, ii. (Plants, Chota Nagpur), 99.]

D.E.P., ii., 12-5.
Pigeon-pea.

CAJANUS INDICUS, *Spreng.* ; *Fl. Br. Ind.*, ii., 217 ; LEGUMINOSÆ. The Pigeon-pea, Embrevade, Pois d'Angole, Cytise des Indes, etc., *dal, cadjan, tuvar* (*tuver*), *tur, thor, arhar* (or *arar, oror*), *rahar dal, lahar, oroha, gela-máh, togari, kanalu, peh-yen-khyung*, etc., etc.

Origin.

History.—The pigeon-pea would seem to have been introduced into the West Indies (Grisebach, *Fl. Br. West Ind.*, 191) and to America from Africa, and apparently through the slave trade. It has been long cultivated in India, but nevertheless no Indian botanist has recorded having found it wild, or even naturalised, so that there would seem little doubt that in India it is an introduced plant. It is not mentioned in any of the early Sanskrit works. In Rheede's time (1686) it was regularly cultivated in Malabar, and bore practically the same vernacular names as at the present day. On the other hand, several travellers mention having found it wild in Africa. Schweinfurth, according to Jumelle (*Les Cult. Colon.*, 1901, 128), for example, discovered it wild in the region of the Upper Nile. Welwitsch (*Cat. Af. Pl.*, i., pt. i., 266) speaks of it as cultivated and wild in the coast districts of Angola—its vernacular name being *jinsonge* or *quinsonge*. Loureiro makes mention of it as both cultivated and wild in China and Cochin-China, but as opposed to that view Bretschneider does not allude to it as having been known to the ancient Chinese scholars. Seemann speaks of it as introduced into Fiji by the missionaries. In Madagascar it is an important and apparently very anciently cultivated plant.

Wild in Africa.

Varieties.

Varieties and Races.—There are two forms of this well-known pea, which by some authors have been viewed as species. They are apparently of independent economic value and hence may be here separately indicated :—

C. bicolor, *DC.* : Sloane, *Hist. Jam.*, 1725, ii., 31 ; Burmann, *Thes. Zeyl.*, 1736, 86, t. 37 ; Hughes, *Hist. Barbados*, 1750, 199, t. 19 ; *Cytisus pseudocajan*, *Jacq.*, *Hort. Bot. Vind.*, 1770, i., 54, t. 119 ; *C. Cajan, Tussac, Fl. des Antil.*, 1827, 4, 94, t. 32 ; *Cytisus Cajan, Descourt., Fl. Pittor. et Med. des Antil.*, 1827, iv., 221, pl. 280 ; *Bot. Reg.*, 1845, xxxi., t. 31 ; Duthie and Fuller, *Field and Garden Crops*, 1882, ii., 20, t. 34. This might be described as a large bush, 6 to 8 feet in height, according to Roxburgh, with a circumference of 20 feet around the extremities of its branches—in other words, twice the size of the next form. The flowers are yellow streaked with purple, and there are four to five seeds in the pods, which are also marked with dark streaks. Roxburgh (the author from whom most recent writers have compiled) tells us that it is commonly sown with the first rains in June, ripens its main crop in about nine months, and yields 600-fold. It is in reality a perennial, but from its yielding a poor second crop, is in India usually treated as an annual. In the West Indies this is called Congo or Angola pea, and in India it is best known by the name *arhar*.

Bush with Yellow-purple Flowers.

Angola Pea.

C. flavus, *DC.* ; Rheede, *Hort. Mal.*, 1686, vi., 23, t. 13 ; Plukenet, *Alm.*, 1696, ii., 293, *Phyt.*, 213, f. 3 ; Rumphius, *Herb. Amb.*, 1750, v., 377, t. 135, f. 2 ; Duthie and Fuller, *l.c.* 20, t. 33. This is a much smaller plant than the preceding. It has been described as having perfectly yellow flowers, and usually only two or three seeds in the pods, which are never spotted. It is known in the West Indies as the no-eye pea and in India as *thur* or *tuver*. According to Roxburgh it is sown in September, occupies the soil as a rule for only three months, and yields 100-fold.

Herbaceous with Yellow Flowers.
No-eye Pea.

Crops.

Rabi and Kharif.—The recognition of these plants as distinct crops can hardly be viewed as having received in India the attention that the subject deserves. They practically correspond respectively to the *rabi* and *kharif* phases of most Indian cultivated plants. In the *Botanical Magazine* (1879, xxxv., 3rd. ser., No. 6440) is given a beautiful illustration, and description by Sir J. D. Hooker of a form of ***Cajanus*** which was grown at the Royal Gardens, Kew, from seed supplied from Calcutta by Sir George King. This proved to be botanically an intermediate form that broke down the specific distinctions of ***C. flavus*** and ***C. bicolor***. Subsequent writers accordingly accepted these as but varieties of one species. In the plant grown at Kew the flowers were pure yellow, and the

Intermediate Form.

stipellæ those of ***flavus***, while the spotted pods were those of ***bicolor***. Many years previously Jacquin cultivated at the Botanic gardens of Vienna two forms of ***Cajanus***, the seeds of which he tells us were obtained from Tranquebar (near Tanjore) and from the Lesser Antilles respectively. The former grew to a much larger size than the latter, and flowered freely. His admirable plate shows the Indian plant to have been ***C. bicolor***. The plant cultivated in the Antilles has been repeatedly figured and described since Jacquin's time, but in all cases it would also appear to be ***C. bicolor***. The inference may, in fact, be drawn that that form is much more tropical in its habitat than ***C. flavus***, which in India is a cold-season crop.

Climatic Influences.

Bombay Races.

Associated Crops.

Period of Growth.

A three-months' or nine-months' Crop.

Mollison (*Textbook Ind. Agri.*, iii., 70-3) does not apparently appreciate the full value of the two botanical varieties indicated. He tells us that in Bombay there are two forms—(1) with white seeds, grown mostly in Gujarat; (2) with red or light-brown seeds, grown to a slight extent in Gujarat and in general cultivation throughout other parts of the Presidency. "These varieties," he then adds, "appear to hybridise freely when grown mixed." "The red-seeded variety does not grow well in the black soils of Surat and Broach." Further on he, however, says the *tuver* is raised mainly as a mixed crop, and participates in the tillage given to its associate. It is grown with *bajra* (in that case being sown from 1st to 15th June); with *juar* (June-July); with *kodra* (June); with *sesamum* (September), etc., etc. Thus in Bombay there are both *rabi* and *kharif* races of this pea, just as in most other parts of India, and these correspond doubtless with the botanical varieties briefly described above. The existence of two separate crops (the seeds of which would most probably not be interchangeable) is directly stated by the Annual Reports of the Department of Land Records and Agriculture, where the area devoted to the *kharif* and *rabi* forms is shown separately. In the *Thana Gazetteer* it is stated that an early crop occurs on the uplands and a dry-weather crop on late or *rabi* soils, and that these ripen in November and February respectively. It is thus certain that the existence of two such crops, one occupying the soil for only three months and the other for nine months, is a far more important circumstance than the colour of the pea, the more so since it seems probable that the peas may be white, red or mottled in both varieties, the colour of the seed being possibly a racial characteristic.

Three Forms in Mysore.

Panjáb Forms.

U. Prov. and C. Prov.

Two Forms.

Bengal and Assam Forms.

Cameron writes of Mysore that there are three forms of ***Cajanus***—a large form confined to gardens, known as *turuk-togari*, and two smaller field forms known as *walada-togari* and *sauna-togari* respectively. Stewart, speaking of the Panjáb, observes, "The yellow and parti-coloured kinds are not uncommon, the one as a cold-, and the other as a hot-weather crop." Of Raipur, we read of there being two forms of *arhar* or *tur*, a small and early form (possibly ***C. flavus***) known as *harona*, and a larger and late kind called *mihi*. Both these are said to be sown at the same time, but the former ripens about two months before the latter. Duthie and Fuller tell us that ***bicolor*** is the form most extensively grown in the United Provinces, and that ***flavus*** takes its place in the Central Provinces. The *tur* grows remarkably well in Nimar—a man on horseback being often completely hidden within the fields. Roxburgh was told of a third form met with on the highlands which constitute the northern boundary of the Circars. J. J. Wood (*Rec. Bot. Surv. Ind.*, ii., 20) says that in Chota Nagpur there are three varieties and that these ripen in January, March and November. Basu (*Agri. Lohardaga*, 1890, 69) observes that there are two forms known as *maghoa* and *cheytoa*, so named from the months when they come into season, but the *maghoa* has much larger peas than the *cheytoa*. So again Banerjei (*Agri. Cuttack*, 1893, 82) says there are two kinds of *arhar*, the *pala* or *chaitra* and the *deo* or *nali*. Of Assam, Basu (*Agri. Ledg.*, 1903, No. 5, 136) remarks that the *dal* grown locally is inferior to the imported pulse, and that accordingly it is more frequently raised with a view to protect sugar-cane, than as a pulse. It ripens in March to April.

Cultivation.

Cultivation.—Hot-season Peas.—Throughout the world pigeon-pea cultivation has been commended as desirable for all tropical countries, on account of the green peas it affords being an excellent substitute for the common garden pea, and it comes into season during the hot months when the ordinary pea is not available. With this object in view its cultivation has been extended into most temperate and moist tropical regions. An excellent

Mixed Crop.
Yield.

account of the plant, for example, will be found in *The Agricultural Gazette of New South Wales* (1892, iii., 6). In India it is most frequently grown as a mixed crop, especially ***var. bicolor***, and more particularly as a rotation crop for cereals. The sowings are ordinarily in drills or lines that divide the field and often are so arranged as to protect the intervening crop from climatic inclemencies. A common system is every fourth row to be *tur*. The yield cannot, therefore, be stated without information as to the extent to which this crop occupies the soil. So again it frequently remains on the ground for a much longer period than its associated crop or crops. If grown alone on good soil the yield may be 2,000 lb. per acre, but as a mixed crop it averages about 500 to 700 lb. or even much less; some of the test experiments in the Central Provinces, for example, show a yield of only 400 lb. It is a hardy plant and thrives in seasons of drought when other crops fail. It is one of the best leguminous restorative plants known to the Indian agriculturist. [*Cf. Agri. Ledg.*, 1894, No. 7, 198.]

Wilt Disease.
Distribution.
Treatment.

Diseases and Pests.—E. J. Butler (*Agri. Journ. Ind.*, i., pt. i., 25-30) has rendered admirable service by his investigations into *The Wilt Disease of the Pigeon Pea and Pepper.* "The former plant," he says, "has been found to suffer habitually from a condition like that of flax (linseed) which is known as "flax sickness" in Europe and America, and which has thrown great difficulties in the way of successful flax cultivation in several countries. The flax disease is due to a parasitic fungus developed in the soil, and an allied fungus is responsible for *arhar* sickness in India." In consequence consecutive cultivation of flax or pigeon-pea on the same soil is followed by disastrous increase of the disease. At present it is "found over an immense extent of country; Bombay, the Central Provinces, the United Provinces and Bihar being the areas most affected." It has been reported from the Panjáb; in fact, "with the exception of Madras," where Butler says he has "neither seen nor heard of it," one may assume that wherever the crop is extensively grown, the disease is to be found. The reader desirous of full particulars should consult Butler's paper. It will there be found that the fungus in question is described to penetrate the tissue of the plant and to accumulate within the vessels that carry the food supplies, thereby causing the pigeon-pea to turn black and decay gradually until it is completely wilted. "It is thus clear that no direct treatment can be successful against a disease of this type. The parasite early enters the internal tissues of the plant, and is then out of reach of any curative application." Our author consequently explains that there remain but two possible methods of diminishing the ravages of this disease. The first is the introduction of longer systems of rotation than are usually followed with *arhar* cultivation, so as to give time for the soil to be freed from infection. The second, the discovery or production of wilt resistent forms of the plant. In 1894, while touring through the Central Provinces and Berár, I discovered a disease very prevalent on the *tur*, and ascertained that it was caused by a parasitic fungus on the roots (*Agri. Ledg.*, 1895, No. 20, 322); and very likely, therefore, it was the disease here dealt with.

Turning now to the pests, it may be observed that a caterpillar, *ille*, often destroys the first crop of pods; but frost is by far the most serious danger. On *usar* (*réh*) soils it will not thrive. [*Cf. Agri. Ledg.*, 1897, No. 13, 231; 1901, No. 13, 424; Maxwell-Lefroy, *Mem. Dept. Agri. Ind.*, 1907, i., 142, 149, etc.]

Area. **Provincial Areas.**

Area and Production.—It is impossible to form any trustworthy conclusions regarding the total supply of this *dal* in India, or of the area under the crop. Mollison speaks of 700,000 acres in the Bombay Presidency. Duthie and Fuller estimate for 3½ milion acres in the United Provinces as partly or entirely under it. In recent Bombay official papers mention is made of 566,465 acres *kharif* and 14,024 acres *rabi* having been in 1902–3 under this crop. It is not known if these figures were worked out as pure or as mixed crops. In the *Season and Crop Report* (1905–6), the area in the Presidency proper is said to have been 443,365 acres. In connection with the United Provinces we read of 2,039,692 acres, doubtless mixed crops, and for the Central Provinces 262,493 acres, both returns being for 1902–3. In connection with Berár it has been stated that for the year named there were 266,709 acres under this pulse, all grown as *kharif* crops. Regarding the other provinces of India no recent estimates are available, so that a full statement of the area for all India cannot be furnished for any one year. It is placed in official statistics under the heading of "Other Food-grains including Pulses," of which the total for all India has, during recent years, ranged from 27 to 29 million acres.

Trade. Price.

Similarly particulars cannot be afforded regarding the trade in the pigeon-pea since it is placed under "Other sorts of Grains and Pulse." Mollison says that the dry pulse sells at from 35 to 40 lb. per rupee, and in exceptionally cheap years 50 lb. or more to the rupee may be obtained. The official publication *Prices and Wages* (1906, 72–3) gives an elaborate statement of the annual returns (seers per rupee) of this pulse in all provinces of India back to 1861. A further table (*l.c.* 122–3) reduces these to quinquennial averages, and the following are the prices given for the five years 1901–5:—Eastern Bengal and Assam, 10·8 seers per rupee; Bengal, 11·75; Agra, 12·59; Oudh, 13·01; Rajputana, 14·18; Central India, 10·32; Panjáb and N.W. Frontier Province, 10·49; Sind and Baluchistan, 9; Bombay, 9·56; Berár, 10·15; Central Provinces, 10·65; Nizam's Territories, 15·97; Mysore, 7·02; Upper Burma, 8·19; Lower Burma, 8·37 (the seer equals approximately 2 lb.).

Food. Split Peas. Pea-meal. Valued by Seamen.

Economic Value.—In India the pulse is highly esteemed by the Natives, who regard it as the third in rank of importance among the leguminous SEEDS. *Taleef Shereef* (Playfair, transl., 1833, 10) describes it at length, adding that a decoction of the leaves makes an antiseptic wash. It enters very largely into the vegetarian diet of the Hindus and is sold either in the form of split peas or as pea-meal, of which sweet cakes are often made. Many of the early European authors, writing of the East Indies, speak of this pea as in demand by seafaring people. Rheede, for example, says it is specially valued as a food for ships' companies. Burmann observes that pigeons live on it, and men chiefly when on board ship. Decourtilz (*l.c.* 222) remarks that from the peas may be prepared a sort of sago much sought after by British and American sailors—an observation that recalls the parody on "The Mariners of England" who lived on "yellow peas" (see **Cicer**, p. 295).

French-beans. Seasons.

Sometimes the tender green pods with their contained peas are in India cooked in curry like French-beans. They constitute in fact an excellent VEGETABLE much neglected by the Europeans resident in India. Of the ripe peas there are, as already indicated, at least two seasons of their coming into market, viz. November to December for the early crop, and February to April for the late. The chief crop is the last mentioned. The plants are cut off close to the ground by a sharp knife and conveyed to the homestead, where they are stacked on the threshing-floor. The leaves and pods are then stripped or shaken off and the grain thrashed out. The leaves form a valuable **FODDER**, and occasionally a pruning of the young shoots is taken and given to cattle. The outer integument of the seed with part of the adhering kernel is a favourite food for milch-cows—it is known as *chuni* (*Agri. Ledg.*, 1895, No. 6, 75). The pea or meal is largely employed as a cattle-medicine. [*Cf. Cattle Diseases*, *Agri. Ledg.*, 1896, No. 28, 275, 283, etc.]

Fodder.

Chemical Composition.

Church (*Food-Grains of Ind.*) gives the composition of the husked pea as:—water 10·5; albuminoids 22·3; starch 60·9; fat 2·1; fibre 1·2; and ash 3·0. The nutrient ratio is 1·3 and the nutrient value 80. "It is wholesome and nutritious when properly freed from the husk, its irritant and laxative character being thus greatly reduced. It is not unusual to find that the higher-priced and finer qualities of this pea have been slightly oiled before sale, to improve their appearance. This practice is not unknown in reference to wheat in the South of Europe." Leather (*Agri. Ledg.*, 1901, No. 10, 356) has published his analyses of some four samples of this pea: one, a white, and two, red peas from Poona, and a fourth from Cawnpore. His results for the white pea may be here given to allow of comparison with the above:—moisture 6·77; oil 6·93; albuminoids 13·25; soluble carbohydrates 51·38; fibre 18·10; soluble minerals 6·44; sand 3·13; total nitrogen 2·45; albuminoid nitrogen 2·12. Leather thus found higher proportions of fibre and minerals than given by most other chemists. [*Cf.* Greshoff, *Chem. Zeit.*, 1903, No. 42.]

Charcoal and Gunpowder.

The stalks are used as fuel, the larger ones being prized for the charcoal sold to the makers of gunpowder. The thin straight branches are employed for roofing and basket-work, as also for the wattling of carts and the tubular wicker-work linings of wells.

Lac-insect (feeding on *Arhar*).

In Northern Bengal and Assam the *arhar* is specially grown as a food-plant for the lac-insect. One of the earliest accounts of this special industry (lac-rearing) was written by Buchanan-Hamilton in his *Statistical Account of Rangpur* (1809). He there gives the plant the name of *mendu-kolai* and says the seed is sown in the spring, generally in the form of a hedge around gardens. In the beginning of the cold season the insects are applied by tying to each bush a small branch containing those about to produce larvæ. A year afterwards the twigs of the bushes are then found to be covered with the lac incrustations (*Agri. Ledg.*, 1901, No. 9, 218). There would seem to be much less lac reared on *arhar* in Bengal nowadays than in former years. In Assam the opinion is held by the Garos and Miris that while the lac-insect may be reared on many plants, the *arhar* forms its most convenient and suitable food. If sown and well watered in November, the young plants are fit to be transplanted at the close of the following rains—end of October—and each should average 4 feet in height. They should be planted 4 feet by 8 feet apart (about 1,360 to the acre), and will be ready to receive the insects two years after date of sowing. They should be charged with stock-lac in November: about 40 lb. will be necessary to the acre. One year later, the crop should be obtained, each bush yielding about 8 lb. or 6 lb. of cleaned lac, which at present rate would fetch about £144 per acre, less expenses. If well cared for and properly pruned, to prevent flowering, seed for next year's crop being left on the bushes, the same plants may continue to yield for several years. [*Cf. Agri. Ledg.*, *l.c.* 232, 271]

Silkworms.

Jumelle (*Les Cult. Colon.* (*Aliment.*), 1901, 128–31) gives a most interesting account of the cultivation of this plant in Madagascar for the purpose of feeding a special silkworm (*landibé*) of that country. This industry exists mainly in the south of the island at Betsileo. It would appear to be a silk that resembles *tasar* or *eri*. The *landibé* is said to be the ***Boroceras cajani*** of entomologists. It lives in the open air, and forms its cocoons among tufts of grass placed within the bushes for that purpose. It lays its eggs in March, is in chrysalis for one month, and takes eight days to spin its cocoon. It requires a warm, sheltered situation. Tussac (*Fl. des Antil.*, 1827, iv., 94–6) also alludes to the fact that a silkworm is reared on the leaves of the Angola-pea. *Arhar* silk would thus seem well worthy the attention of the Indian cultivators as a possible additional source of revenue.

Arhar Silk.

CALAMUS, *Linn.* : *Fl. Br. Ind.*, vi., 436–62 ; Beccari, *Rec. Bot. Surv. Ind.*, ii., 197–230 ; Gamble, *Man. Ind. Timbs.*, 1902, 734–7 ; Mason, *Burma and Its People* (ed. Theobald), ii., 137–9 ; Brandis, *Ind. Trees.*, 1906, 650–4 ; PALMEÆ. A genus of tropical palms, often climbing ; the long rope-like stems of several species constitute the chief qualities of the "Canes and Rattans" of commerce.

D.E.P., **i., 404–5 ;** **ii., 16–24,** **98–102.** **Canes and Rattans.**

History.—Rattan, it may be explained, is synonymous with Cane, is in fact identical, being the Malay word *rotan*—a cane. In modern usage the word "reed" denotes as a rule a hollow grass-stem (the bamboo is an arborescent reed), and the word "cane" implies a solid palm-stem. The separation into canes and reeds, whether etymologically correct or not, is a convenient industrial distinction. In fact the only desirable exception might be made in the case of the solid bamboos (male bamboos, as they are often called). These are used as walking-sticks, lance-shafts, and even more directly for some of the purposes for which the true canes are specially employed. But certain species of one or two other genera of palms such as *Dæmonorops* and *Plectocomia* are used indiscriminately with those of *Calamus* as true canes.

Species and Varieties.—Before proceeding to discuss the Indian trade in "Canes and Rattans" or to furnish particulars regarding the associated industry of Basket or Wicker-work, it may be desirable to enumerate the more important species and to exhibit, while doing so, their habitats, their better-known vernacular names, and their special or individual properties and uses :—

Calamus acanthospathus, *Griff.* ; the *gouri-bet, pukha-bet, rue, ru,* etc. An extensive climber found in Eastern Nepal, Sikkim, Bhutan and the Khasia hills at altitudes of 2,000 to 6,000 feet. Gamble says, "the best of the rattan canes of Sikkim. The canes are rather thick, and where obtainable are used for cane-bridges, chair-making, and walking-sticks, but are now getting scarce."

D.E.P., **ii., 16.** Sikkim.

C. gracilis, *Roxb., Fl. Ind.*, iii., 781. The *mapúribet, kraipang, hundi-bet.* Upper Assam, the Khasia hills, Cachar and Chittagong—a species with very slender canes.

D.E.P., **ii., 20.** Assam.

C. Guruba, *Ham.*, in Mart., *Hist. Nat. Palm*, iii., 206, t. 175, f. 1 ; (*Dæmonorops Guruba, Mart., l.c.* 330, *var. Mastersianus* and *var. Hamiltonianus*). The *keyini* (or *kyeing-ni*), *sundi-bet, quabi-bet.* A scandent plant met with in the forests of Bengal, Assam, the Khasia hills, Chittagong and Burma. The slender canes are used in basket-work.

D.E.P., **ii., 20.** Assam and Burma.

C. latifolius, *Roxb., Fl. Ind.*, iii., 775 ; Beccari (*l.c.* 211) regards *macracanthus* as a subspecies. The *dangribet, brúl, korak-bet, sain, yama, yamata kyeir* (or *yan-ma-hta*) ; and *var. macracanthus*—*ruebee, rabi, groom, phekori-bet.* A stout climber found in the Sikkim Himalaya, the Terai and East Bengal to Assam, Chittagong and Burma. These canes are very strong and much in demand for walking-sticks and all forms of basket-work ; the *brúl* has the reputation of being best suited for walking-sticks. This is by far the strongest cane that finds its way into Indian trade at all plentifully. By most persons, in fact, it would very possibly be regarded as the true rattan of the commerce of the Eastern side of India and of the greater part of Burma.

D.E.P., **ii., 21.** East Bengal and Assam.

C. leptospadix, *Griff.* The *lat, chemchun*—a scandent slender species of the damp valleys of the Eastern Himalaya and Terai swamps, the Khasia and Naga hills and Manipur. Canes thin and apparently not of much value, though used locally.

D.E.P., **ii., 21.**

C. Rotang, *Linn.* ; Roxb., *Fl. Ind.*, iii., 777 ; *Fl. Br. Ind.*, vi., 447 ; Mart., *Hist. Nat. Palm*, iii., 334, t. 116, f. 8 ; Blume, *Rumphia*, 1847, iii., 33 ; *C. Roxburghii, Griff.*, in *Calc. Journ. Nat. Hist.*, v., 43 ; *C. monicus, Roxb., l.c.* 783 ; *C. scipionum,* partly *Lamk., Encycl.*, vi., 304 ; Dodge, *Useful Fibre Plants of the World*, 102. A very numerous assortment of vernaculars might be given for this plant such as :—*bet, bent, pepa, pemu, prabba, veta, natar, perambu, rotan,* etc. An extensive climber found in the Central Provinces, the Deccan, Karnátak, Konkan and Ceylon. According to Roxburgh it is a native of Bengal and the

D.E.P., **ii., 22.** Central, Western and South India.

Coromandel Coast, delights in a rich moist soil, where there are bushes and trees for it to climb on. It seems probable that Roxburgh may not have sufficiently separated this from the two following species as cane-yielding plants. ***C. Rotang*** proper is not met with in Bengal. The slender stems are the common rattans of Central and Southern India; they are used for basket- and wicker-work, chairs, mats, blinds, etc., but are not strong though easily worked. [*Cf* Taylor, *Topog. Stat. Dacca*, 1840, 52; Brandis, *Ind. For.*, 1887, xiii., 55; Thiselton-Dyer, *Ind. For.*, *l.c.* 185.]

D.E.P., ii., 23. North India an Bengal.

C. tenuis, *Roxb.*, *Fl. Ind.*, iii., 780; Griff., *Palms Brit. Ind.*, 1850, 57, t. 193, A, B, C; Prain, *Rec. Bot. Surv. Ind.*, ii., 347. This is the *bet, bent, chachi-(sanchi) bet, bandhari bet, kring, jalla bet, jali*, etc. A very long scandent plant met within the Sub-Himalayan tracts from Dehra Dun eastwards to Assam, Sylhet, Chittagong and Pegu. This is the common cane of Northern India and Bengal. It is largely used for basket-work, mats, screens, chairs, etc., etc. The fruit is eaten in times of scarcity. [*Cf.* Innes, *Jungle Prod., etc.*, 1898, 13.]

Eastern Peninsula.

C. viminalis, *Willd.*; *Palmajuncus viminalis, Rumph.*—a Javan plant; *var. fasciculatus, Becc.* (*C. fasciculatus, Roxb., Fl. Ind.*, iii., 779). The *bara-bet, pepa beti, amla vetasamu, kyeinga*, etc., and according to Roxburgh it is the *umba-vetus* of Sanskrit. It is a stout scrambling and climbing species of Lower Bengal, Orissa, the Karnátak, Chittagong, Burma, the Andaman Islands, Penang and Cochin-China. Cane thin but strong, makes excellent walking-sticks and is the chief rattan of the Eastern Peninsula.

D.E.P., ii., 21. East Bengal.

Dæmonorops Jenkinsianus, *Mart., Hist. Nat. Palm.*, ii., 327; Prain, *Rec. Bot. Surv. Ind.*, ii., 347. This is the *gola-bet, gallah*, etc. A stout scandent rattan found in Eastern Bengal, Darjeeling Terai, Assam, the Khasia hills, the Sundribans and Chittagong. The canes are long but are said to be rather soft, though extensively used for basket-work.

D. Kurzianus, *Becc., l.c.* 219. A stout species of the tropical forests of the Andamans, giving useful canes and a kind of dragon's-blood gum.

Plectocomia himalayana, *Griff.*; *Calc. Journ. Nat. Hist.*, v., 100. *Fl. Br. Ind.*, vi., 478. The *runul, ranol*, etc. A gregarious climber found in the Sikkim Himalaya. The thin stems are employed for tying fences and in common basket-work.

D.E.P., ii., 98 102. Dragon's-blood.

Canes and Rattans: Basket- and Wicker-work.—Few plants are more useful to the inhabitants of moist tropical regions than the canes and rattans. The long scandent stems constitute the canes of commerce.

The stems when freshly cut contain a large quantity of liquid, which may be collected by blowing through short lengths, and from this, by evaporation, a red resin may be obtained. One of the best-known qualities of that resin is sometimes called "East Indian Dragon's-blood." This is, however, for the most part prepared from the fruits of several species of ***Calamus***, met with in Eastern Sumatra, South Borneo and Penang. The gum exudes naturally from between the scales of the fruit, but inferior qualities are obtained by boiling the fruits or by tapping the stems. The only Indian species hitherto reported as affording this resin is ***D. Kurzianus***—a species already briefly indicated. The false Dragon's-blood, met with in Indian commerce, is imported into Bombay from Sumatra, Penang, etc., in large cakes or is found compressed into bamboo tubes. The true Dragon's-blood is, however, procured from Socotra and is derived by tapping the stems of several species of ***Dracæna*** not ***Calamus***. [*Cf. Yearbook of Pharmacy*, 1884, 234–6; 1897, 180; *Pharm. Journ.*, 1893, xxiv., 47, 108; *Pharmacog. Ind.*, iii., 532–5; *Kew Bull.*, 1906, 197–9.]

Edible Fruits.

The fruit in the species of ***Calamus*** is produced in great clusters, and the inner succulent layer is often an edible refreshing bitter-sweet pulp. The roots and young sprouts are eaten as vegetables and somewhat resemble asparagus. But the species of the above-mentioned genera owe their chief

Rope Substitutes. Basket-work. Mats. Walking-sticks. Whangee Canes. Paper Material.

value to the great strength more particularly of the outer woody layer of their long flexible stems. As substitutes for ropes these are invaluable, and in the countries where they abound, canes 300 to 400 feet in length are frequently employed as the bearing-ropes of suspension-bridges. They are also used in towing heavy objects, stones, logs of timber, etc., and formerly were much valued in the East as cables for ships. The smaller canes are extensively employed throughout the world in basket-work both entire and stripped. Chairs, sofas, couches, baskets, etc., are constructed of entire canes wound round and round and fastened to each other by thin strips of the cane-bark. When the interstices are filled up, they become water-tight baskets and granaries. A strong and durable floor-mat is similarly made of these canes placed close together and held in position by binders of cane-bark. Canes are also very largely used as walking-sticks, umbrella-handles, and to give strength in saddlery and harness. Loureiro (*Fl. Cochinchin.*, 1790, 210) under *C. Scipionum* says, " Pro baculis ex dignitate, vel elegantiâ manu gestandis "—a description fully applicable to the Malacca and Whangee canes of to-day. But of course the chief European use for canes is in furniture and basket-making. Machinery is now utilised in stripping the barks into cane-ribbons, thus leaving the core in the form of a perfectly round and even rod. These rods are employed in the construction of fancy baskets, chairs, window-blinds, where great strength is not essential, and they have the advantage over the silicious stronger bark-ribbons in that they take colour readily. The waste fibre obtained during stripping and trimming the ribbons and cane-rods is used in upholstery along with, or as a substitute for coir. Wiesner (*Denkschr. Akad. Wiss. Wien. Math.-Nat.*, 1902, lxxii., 15–6) refers repeatedly to the Chinese employment of rattans in the manufacture of paper. Tschirch (*Indische Heil-und Nutzpflanzen*, 1892, 169) very picturesquely describes the varied uses of the cane from caned boyhood to cane-seated dotage. His illustrations are forcible, but add little or nothing new. [Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 255–61.]

Trade. Production. Imports. Exports.

Trade in Canes.—The Forest Departments of the various provinces of India, including Burma, publish annual reports from which it might be gathered that the yearly crop of canes amounts to about 10,000,000 maunds and the annual revenue therefrom from Rs. 50,000 to 60,000. The Reports of the Conservators of Forests in Burma for the year 1904–5, for example, show a total revenue from canes amounting to Rs. 37,775. The imports of canes and rattans into India from foreign countries may be said to average from 30,000 to 40,000 cwt., valued at from 2 to 3½ lakhs of rupees (38,436 cwt., valued at Rs. 3,85,674 in 1906–7). These come mainly from the Straits Settlements and Siam. The exports to foreign countries of Indian canes come to from 1,000 to 3,000 cwt., valued at from Rs. 20,000 to Rs. 50,000 (2,427 cwt., valued at Rs. 38,100, in 1906–7), but in addition there is also a re-export trade (foreign canes exported) formerly of about the same quantity and value as that just mentioned, but showing a considerable diminution in recent years (673 cwt., Rs. 11,291, in 1906–7). It is thus significant that India, with its vast supplies of canes and rattans, should not be independent of foreign tropical countries, and the explanation may possibly lie in the cheaper sea as compared with land transit. Large towns like Bombay, Calcutta and Madras find it more economical to obtain their supplies from the Straits than from the inland forests of India. (See **Baskets**, p. 115; also **Mats and Matting**, p. 775).

PINNAY OR DOMBA OIL

[*Cf. Paulus Ægineta* (Adams, transl.), iii., 171; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), i., 96–7; Birdwood and Foster, *E.I.C. First Letter Book,* 201, 480; Milburn, *Or. Comm.*, 1813, ii., 133, 506; Robinson, *Desc. Acc. Assam,* 1841, 53–4, 360, 368–9; Lewin, *Hill-tracts of Chittagong,* 1869, 131–2; Jackson, *Comm. Bot., etc.*, 1890, 158; also in *Journ. Soc. Arts,* xxxvi., 1109, 1122; *Agri. Bull. Straits and Fed. Malay States,* April 1903, 129–36, 157–60; *Bull. Imp. Inst. Board Trade Journ.*, suppl., Dec. 31, 1903; Wiesner, *Die Rohst. des Pflanzenr.*, i., 172, 339; ii., 59, 185, etc.]

D.E.P., ii., 29 33. Mast-wood.

CALOPHYLLUM INOPHYLLUM, *Linn.*; *Fl. Br. Ind.*, i., 273; Gamble, *Man. Ind. Timbs.*, 57; Cooke, *Fl. Pres. Bomb.*, i., 80; *Pharmacog. Ind.*, i., 173; Brandis, *Ind. Trees,* 1906, 54; GUTTIFERÆ. Mast-wood, the *sultana-champa, surpan, surangi, pinnay, punang, puna, undi, ponnyet,* etc.—*punngaa* (Sansk). An evergreen tree, which in some localities, especially when near the sea, attains a considerable size. It is indigenous throughout the Western Peninsula, Orissa, Ceylon, Burma and the Andaman Islands, and is distributed to the Malay, Polynesia, Australia and the islands of Eastern Africa.

Poon Spa

Species and Varieties.—Besides the above there are four other species of ***Calophyllum*** worthy of special mention in this place. These are:—(1) ***C. polyanthum***, *Wall.*, the *kandeb, kironli, kraidone*; an evergreen tree of Northern and Eastern Bengal, the Khasia hills, Chittagong and Martaban. (2) ***C. spectabile***, *Willd.*, the *pantaga, lalchumi, dakar-táládá*; a tall evergreen tree of Tenasserim, the Andaman Islands and Ceylon. (3) ***C. tomentosum***, *Wight,*—the Poon Spar, *nagari, surhoni,* etc.; a large evergreen tree often 150 feet in height, self-propagated in the western coast forests from N. Kanara to Travancore. (4) ***C. Wightianum***, *Wall.*; the *bobbi, irai, cheru pinnay,* an evergreen tree found along the Western Ghats from the Konkan to Travancore.

Tacamahaca.

Resin.

Oil:
Pinnay or

edicine.

Extract.

Properties.—There appears to be little doubt that the true *Gum Tacamahaca,* formerly attributed by some writers to ***C. inophyllum***, is neither obtained from that nor from any other Indian tree. But when wounded the stems and also the fruits of the mast-wood exude a small quantity of bright-green pleasantly scented RESIN (soluble in alcohol) which is not collected nor made any use of at the present day. Rheede observes, however, that it is emetic and purgative, so that it would appear to have been formerly of medicinal value. From the seeds is expressed a greenish-coloured OIL, known as Pinnay or Domba Oil. According to some the yield is as great as 60 per cent. by weight, and the oil is said to congeal when cooled below 50°. The seeds are collected twice a year, in August and again in February. The oil possesses a disagreeable odour and flavour, but is fairly extensively used for burning, and is valued, especially in Polynesia, as an external application in rheumatic affections. Mixed with *chaulmagra* oil (p. 1068) is also employed for exanthematous eruptions. In Pondicherry the oil is believed to be very useful in the treatment of scabies, a property specially mentioned by Rheede in 1686, and again by Rumphius in 1750. The chief centres of production are Bombay, Goa, Travancore, Tinnevelly, Tanjore, Puri, etc. It is said to fetch a little more than half the price of cocoanut oil and is fairly extensively exported from India to Burma. The oils of ***C. tomentosum*** and ***C. Wightianum*** are similarly expressed from the seeds, but do not differ in properties and uses from that of ***C. inophyllum***. Rumphius affirms that in his day the bark was boiled down along with that of a plant which he named *Sideroxylon,* and the decoction given as a purgative; he also states that warriors carried a little bottle of the oil by their sides and smeared it on their spears and bolts, believing that they were thereby more likely to pierce the objects against which they were thrust.

Timber.

Masts, Spars, etc.

The TIMBER is moderately hard and close-grained, and by Sebert (*Les Bois de la Nouvelle Calédonie*) is believed to be magnificent for cabinet-work. All the species, and in particular the Poon Spar ***C. tomentosum***, are highly serviceable for masts, spars, railway-sleepers, machinery, etc., but for these purposes are much less in demand than formerly. Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), i., 67) alludes to the "long masts for shippes" sold at Cananor, and Hamilton (*New Acc. E. Ind.*, 1744, i., 267) says the Poon-masts are heavier and stronger than fir. They are sometimes employed, especially ***C. polyanthum***, in boat-building. [*Cf.* Elliot, *Fl. Andh.*, 1859, 155, 160; Moodeen Sheriff, *Mat.*

Med. Mad., 1891, 46–7; Bidie, *Cat. Prod. Paris Ex.*, 1878; *Man. Trichinopoly*, 1878, 77; Lisboa, *Useful Pl. Bomb.*, 12; Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1904–5, 24, etc.]

D.E.P., ii., 33-49. Madar.

CALOTROPIS GIGANTEA, *R. Br.*; and **C. procera,** *R. Br.*; *Fl. Br. Ind.*, iv., 17; Wight, *Illust. Ind. Bot.*, ii., t. 155, 156A; also *Ic.*, t. 1278; Gamble, *Man. Ind. Timbs.*, 491; Cooke, *Fl. Pres. Bomb.*, ii., 151; ASCLEPIADEÆ—the Swallow-worts.

Habitat.—The two species indicated above are so nearly the same from the practical standpoint that they may here be treated conjointly. The former is an erect spreading perennial bush which chiefly frequents waste lands in the warm moist tracts of most tropical countries, in India being especially abundant in Bengal, Assam, South India, and distributed to Ceylon, Singapore, the Malay and China. The latter is a slightly smaller plant, met with chiefly in the drier regions, and so far as India is concerned is most abundant in the Sub-Himalaya (from the Indus to the Ganges), also in Central India, Rajputana, the Deccan and Upper Burma, and is distributed to Persia and Tropical Africa. Both species are known by the following names:—*madár* (sometimes written by Europeans as *mudar* or even *muder*), *ák*, *ákanda*, *árka*, *rui* (a name specially suggested by the silk-cotton), *yercum*, *erukkam*, *jilledu*, *yekka*, *erukku*, etc. But the former species is sometimes called the purple and the latter the white *ákanda*—the *árka* and *álarka*. The name *madár* is derived from the Sanskrit *mandára*, hence the synonyms *rudra*, *aditya*, *surya-pattra*. To its name *arkaparna* (sun or lightning-leaf) is doubtless due the tradition of its blinding properties.

History.—One of the earliest European writers to describe this plant was Prosper Alpinus (*De Pl. Ægypti*, 1592 ch. xxv.). He tells us that it is the *beidelsar* of Alexandria, where it grows in damp places. Rheede was the earliest Indian botanist to narrate its properties (*Hort. Mal.*, 1679, ii., t. 31), and he furnished a most accurate drawing of it. He calls it *ericu*. Rumphius (*Herb. Amb.*, 1755, vii., 24, t. 14, f. 1) gives a poor illustration but describes the plant in great detail under the name of *mador*. Jones (*As. Res.*, 1798, iv., 267) deals with it under the name *arca*. Roxburgh placed it in the genus ***Asclepias***, and Robert Brown a little later assigned to it a separate position under ***Calotropis***. It is a sacred plant with certain Hindus, and is associated with the observances of the *maruts* or winds, the demigods of *rudra*. The ancient Arabs also appear to have had superstitious beliefs regarding it since they associated it with sun-worship. It is a popular tradition in many parts of India that the great Emperor Akbar was so named from having been born under the shade of an *ak* bush. It is the *ushar* of the Arabs and the *khark* of the Persians, but the former seems to be a generic word for milk-yielding plants and was possibly restricted to ***Calotropis*** at a comparatively late date. Abu Hanifeh was perhaps the first Arab writer to give an explicit account of it, but much useful information will be found in the writings of Ebn Baithar (Southeimer, transl., 1842, ii., 193). [*Cf. Joret, Les Pl. dans L'Antiq.*, 1904, ii., 354.]

Sacred to Rudra.

Products.

Properties and Uses.—This plant may be said to yield GUTTA-PERCHA from the milky sap; a strong FIBRE from the bark; a useful FLOSS from the seeds; and a MEDICINE from the root-bark. Space cannot, however, be afforded to do more than review even these properties very briefly, and there are many minor ones that cannot even be mentioned.

Gutta-percha.

The Gutta-percha.—The inspissated and sun-dried sap (milk) drawn from the stems constitutes the *madar gutta* of India. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 29) calls it a pseudo-gutta and gives its composition as "37·9 insol.; 52·9 resin; and 9·2 ash." He then adds that it contains large quantities of *alban* and *fluavil* resins (see p. 627). There are large tracts of the sandy deserts of Rajputana and Central India, as

Plant Common.

Useful Crop for Poor Soils.

Method of Tapping.

Defect of the Gutta.

also of Sind, in which this plant is not only the most prevalent but almost the only form of vegetation met with. In many instances also it has been observed to be the pioneer in the reclamation of sterile tracts (see **Alkalis**, *Réh*, p. 53). If, therefore, a demand could be originated for any one or all collectively of the products of this plant, much good might result to India. Its production could be fostered and by selection and cultivation the quality and quantity of the produce improved, until the plant assumed the condition of a regular crop for poor soils. But unless some method could be designed for extracting the milk from shoots cut on account of their fibre, it is feared that it would not pay to tap the plant specially for its gutta. The stems and twigs are too small and the yield from each too little to justify the opinion that methodic tapping would prove remunerative as an industry by itself. Moreover, it has been found by chemical experiment that ***Calotropis*** gutta, being a fairly good conductor of electricity, is not suited for electrical purposes and is thus very possibly debarred from one of the most profitable markets for this class of product. Heyne (*Tracts, etc., Ind.*, 1814, 245) says that the milk instead of reddening vegetable blue colours, changes them to green. [*Cf. Kew Bull.*, 1886, 45.]

Bark Fibre.

Retting Impossible.

Yield.

Hardly distinguishable from Silk.

Great Strength.

Bark Fibre.—The bast fibre has attracted considerable attention and been spoken of as one of the best of Indian fibres. The great difficulty appears to consist in the inability to separate it rapidly and cheaply. Unfortunately the fibre cannot be prepared by retting the stems since it is reported to rot when so treated, and yet the cleaned fibre when made into fishing lines and nets (as is the case in Karachi) seems quite durable and very strong, especially when used in sea-water. Mr. Liotard, after many experiments performed in Calcutta with fibre-extracting machinery generally, arrived at the unfortunate conclusion that the hopes formerly entertained by himself and others regarding this particular fibre were never likely to be realised :—(1) because of the small percentage of fibre (1·56) to weight of stems, and (2) the shortness of the ultimate fibre. But in recent experiments conducted at the Imperial Institute with a sample procured from Madras, Dunstan found that the staple measured fully 12 inches. [*Cf. Agri. Ledg.*, 1899, No. 2, 7.] Dodge (*Useful Fibre Plants of the World*, 1897, 104) observes that an acre of ground planted 4 by 4 feet with this plant will yield 10 tons of green stems and 582 lb. of fibre : this would mean a yield of roughly 2·6 per cent. He then adds that the fibre possesses many of the qualities of flax though somewhat finer. Its fineness, tenacity, lustre and softness, in fact, fit it for many industrial purposes. Cross and Bevan found that when nitrated it could hardly be distinguished from silk, and long years ago Wight showed that a rope of this fibre broke with a weight of 407 lb. when a similar rope of cotton gave way with 346 lb., and coir with 224 lb. It is, however, quite incorrect to affirm, as has been done by Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 317), Dodge and others, that this fibre is widely used in India. Although prepared to a small extent for very special purposes, the greatest possible difficulty was experienced in procuring the few pounds required.

Paper Materials.

Mr. G. W. Strettell (*New Source of Revenue to India*) advocates the value of this plant as a paper material. Routledge did not form a high opinion of its qualities. [*Cf. Kew Rept.*, 1877, 37.] It may thus be fittingly concluded that were it found possible to utilise the gutta as an additional source of revenue, the fibre, either for textile purposes or paper-making, might, in spite of all that has been said to the contrary, prove worthy of special consideration. [*Cf. Agri. Ledg.*, 1899, No. 2.]

Floss.
Silk-cotton.
Unsuited for Certain Textiles.
Cellulose Low.
Fancy Textiles.
Intermittent Supply.
Upholstery.
Fishing Lines and Nets.
Rugs.

Floss.—The coma of hairs or floss from the seeds constitutes one of the so-called vegetable silks or silk-cottons. This was chemically examined by Cross (*Agri. Ledg.*, 1897, No. 17, 365) and found to possess an abnormally high percentage of *furfurol.* It was further believed to give evidence of being unsuited for some of the purposes of the textile industries. Dunstan, in a report dated November 18, 1904, speaks of ***Calotropis*** floss as containing a much smaller proportion of cellulose than cotton. He shows ***C. gigantea*** floss to contain 64·3 per cent. cellulose, and ***C. procera*** 69·8 per cent., while under similar conditions cotton yields 95 to 96·5 per cent. In practical experiments it has been found that the staple was too short and too light for existing machinery, the latter property allowing it to be blown away. It is, however, a soft, very white floss, with a beautiful silky gloss, and has been repeatedly spun experimentally in Europe, and the textile produced much admired. Reporting on a sample of the floss submitted to him by the Imperial Institute in 1897, Mr. C. E. Collyer observed that some years previously the floss had been in demand for fancy textile purposes, but that it had dropped out of use owing to the difficulties arising from variation in the quality of the parcels sent and the intermittency of the supply when requirements arose. He thought that the trade might be revived if a moderate but continuous supply could be guaranteed. Good quality floss might realise 4*d.* to 5*d.* per lb. The pods and seeds should be removed but the floss left in its natural condition unopened and discoloured portions removed. Notwithstanding all this, no progress has been made in the utilisation of the fibre. In India it is largely employed for stuffing quilts, its lightness being of great advantage, and in upholstery it holds a recognised position, since pillows and cushions stuffed with it are said to be very cool and refreshing. It is also to some extent regularly spun and made into fishing lines and nets. At the Delhi Durbar Exhibition, His Highness the Nawab of Bahawalpur showed one or two rugs woven of *madar* floss, and these were much admired and supposed by many to have been made of silk. C. Latimer (*Monog. Carpet-making Pb.*, 1907, 9) speaks of the attempt being made in Bahawalpur to grow the *ak* required in carpet-weaving. [*Cf. Kew Rept.*, 1881, 32–3; Watt, *Ind. Art at Delhi*, 1903, 433; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 70.]

Famed Textiles.
Grass-cloths.

Early Records of the Floss.—Such then is all that can be said of the utilisation of this floss at the present day. But there would appear to be little doubt that a few centuries ago this fibre was regularly spun and woven into some of the most beautiful textiles for which India was then famed. Human labour was of much less value then than at the present time. Modern advances coupled with the import of cheap European goods seem to have destroyed the old industry. It would appear fairly certain that the *madar* floss was the "grass," the "cloth of herbes," "herba," etc., of early European travellers and traders in Bengal, more especially Orissa. Further that the traffic they allude to gave to the English language the expression "Grass-cloth," which later on became associated with a textile derived from China. Thus Cæsar Frederike about 1563–7 (*Hakl. Voy.*, ii., 358) speaks of "Cloth of herbes,"—"a kinde of silke which groweth amongst the woodes without any labour of man, and when the bole thereof is growen round as bigge as an orenge, then they take care onely to gather them." Rhea could never have been found as a wild plant in Orissa, and the allusion to the "bole" or fruit from which the fibre was obtained precludes rhea from consideration altogether. The passage most unquestionably denotes ***Calotropis gigantea.*** This view is

"Hearbe Bengalen"

confirmed by Fitch in 1585 (*Hakl. Voy.*, ii., 359), who gave an account of his explorations of the Ganges, including Orissa (Orixa, as he calls it) where there was "great store of cloth which is made of Grasse which they call *yerua*." That vernacular name is clearly a form of the word that denotes **Calotropis** throughout Orissa and the Karnátak to this day. Doubtless also Linschoten's "Hearbe Bengalen" was the same textile. I have purposely made reference to Linschoten under **Bœhmeria nivea** because all modern writers whom I have been able to consult quote the above passages, and several others to the same effect under rhea, in place of **Calotropis**, to which they most undoubtedly belong. Pyrard, who visited India in 1601–10, in his chapter on Bengal (*Voy. E. Ind.* (ed. Hakl. Soc.), i., 328–9) makes mention of the silk herb being brighter than silk itself. Coming to more recent dates, Alexander Hamilton (*New Acc. E. Ind.*, 1727, i., 393), who in 1688 visited Bengal and passed up the Ganges to Benares and Patna, describes Balasore as producing manufactures of cotton, silk, mixed silk and cotton, and of "*herba* (a sort of tough grass) of which they make *ginghams*, *pinascos*, and several other goods for exportation." Even so late as 1813 Milburn mentions among his Bengal piece goods "herba taffaties."

"Herba Taffaties."

Though it is certainly most surprising that this ancient industry in silk-cotton textiles should have died out completely and been all but forgotten, it is a useful object-lesson of the possibilities of the future, which manufacturers would do well to consider. (For other Silk-cottons, see **Bombax**, p. 168.)

Medicine.

Intermittent Fevers.

Dysentery.

Medicine.—It would take many pages to indicate even a tithe of the information that exists on the varied medicinal properties of the milk, the flowers, the leaves and the root-bark. The late Dr. Kanny Lall Dey regarded *madar* as a useful medicine when given during remission of intermittent fevers, and especially if these were associated with eczema. The majority of Indian medical writers extol the merits of the root-bark in the treatment of dysentery. In order to verify these opinions, the study of *madar* was taken up by the Central Indigenous Drugs Committee of India. Authentic parcels of the root-bark were procured and made up in the form of both a powder and liquid extract. These preparations were issued to a selected number of Hospitals and Dispensaries throughout India, with the suggestion that they should be used as alteratives and alterative tonics. By chemical tests it had been previously ascertained that the bark of mature plants was preferable to that of immature ones, since they contained a higher percentage of the acid and bitter resinous matter on which the property depended. Ultimately an extensive series of reports came to hand (*Rept. Cent. Indig. Drugs Comm.*, 1901, i., many passages), the combined verdict of which would seem to be that as a substitute for ipecacuanha it is not so satisfactory as its reputation would seem to imply. In fact in acute dysentery and chronic diarrhœa it is found undesirable and certainly less efficacious than ipecacuanha. When given in large doses it frequently occasioned nausea and vomiting, so persistent and severe as to make the drug objectionable if not dangerous. In small doses of say 3 to 5 grains of the powder (preferably) its action on the stomach was that of a mild stimulant, hence the opinion was often expressed that it might with advantage be combined with cinchona in the treatment of certain fevers. As an emetic the powder, in doses of 30 to 40 grains, was found very effectual. In the *Hemp Drugs Commission's Report* (1893–4, i., 156) it is mentioned that the juice of the *madar* is employed to enhance the potency of *ganja*. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 5; Taylor, *Topog. Stat. Dacca*, 1840, 57; Hooker, *Him. Journ.*, 1854, i., 36–7 (temperature of leaves and sap); Elliot, *Fl. Andh.*, 1859, 74, 111, 162, 176; Jackson, *Comm. Bot.* 19th Cent., 1890, 127; *Pharmacog. Ind.*, ii., 428–37; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 56–7; Collett, *Fl. Sim.*, 1902, 315; *Gaz. Multan*, 1901–2, 17.]

Age of Bark.

Doubtful Substitute for Ipecacuanha.

Emetic.

D.E.P., ii., 65-83; vi., pt. iii., 417-79.

Tea.

CAMELLIA, *Linn.* : *Fl. Br. Ind.*, i., 292-3 ; *Frutex The*, Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, 1631 in Piso, *Ind. Utri. re Nat. et Med.*, 1658, pl. 88 ; *The Sinensium*, Jacob Breyn, *Exot. Pl.*, 1677, 111-5, with plate (said to have been made after a sketch by William ten Rhyne) ; *Thea*, Kæmpfer, *Amo. Exot.*, 1712, 605-31, pl. 1-2 ; *Thea japonensis*, Valent., *Hist. Simp.*, 1722, 132-43 and 2 pl. ; *Bohea Tea and Green Tea*, Hill, *Exot. Bot.*, 1759, pl. 21-2 ; *Thea bohea* and *T. viridis*, Lettsom, *Nat. Hist. Tea*, 1772 (new ed. 1799) with 2 coloured pl. ; *T. viridis*, Smith in *Rees's Cycl.*, 1819, xxxv. ; *T. stricta, bohea* and *viridis*, Hayne, *Gewachse*, 1821, vii., pl. 27-9 ; *C. Thea* and *C. viridis*, Link, *Enum. Pl. Hort. Berol*, 1822, ii., 73 ; *T. viridis* and *T. bohea*, Booth, *Trans. Hort. Soc.*, 1830, vii., 519 ; *T. viridis, Bot. Mag.*, 1832, No. 3148 ; *C. bohea* and *theifera*, Griffith, *Notulæ*, 1854, iv., 553, 558; *Ic.*, iv., t. 601, ff 1-3 ; *T. viridis* and *bohea*, Choisy, *Mem. Soc. Phys. Genève*, 1855, xiv., 151 ; *T. chinensis*, Seemann, *Trans. Linn. Soc.*, 1859, xxii., 337-52, t. 61 ; Money, Prize Essay in *Journ. Agri.-Hort. Soc. Ind.*, 1871, iii., 143-441 ; Thiselton-Dyer, *Journ. Linn. Soc.*, 1873, xiii., 329 ; Heuzé, *Les Pl. Indust.*, 1895, iv., 206-7 ; Watt, *Pests and Blights of the Tea Plant*, 1898 : Watt and Mann, *l.c.* 1903 ; Watt, *Tea and Tea Plant, Journ. Roy. Hort. Soc.*, 1907, xxxii., 64-96 ; TERNSTRŒMIACEÆ.

Botanical Name.

Species and Varieties of Tea.—Linnæus (*Gen. Pl.*, 1737) indicated two genera, ***Thea*** and ***Camellia.*** The differences he established turned on whether or not the stamens were free from each other or united, and on the number of cells and seeds in the fruit. Accordingly he placed ***Thea*** in *Polyandria Monogynia* and ***Camellia*** in *Monadelphia Polyandria.* Subsequently (*Sp. Pl.*, 1753, 515, 698) Linnæus assigned the tea plant as the type of ***Thea*** and the Japanese Camellia as the type of ***Camellia.*** But it has since been abundantly established that Linnæus was incorrect in regarding the stamens as being free in the tea plant, and it is a matter of everyday knowledge that on the same tea plant fruits may be found with one, two, three or more seeds. Modern botanists are accordingly agreed that the two genera cannot be separately upheld. Hence it may be regarded that priority of accurate generic recognition of the structural peculiarity of the stamens (were there no other considerations) necessitates the retention of the name ***Camellia***, and the reduction of ***Thea.*** Turning now to the specific name. In the first edition of the *Species Plantarum*, Linnæus (without giving any description) called the tea plant ***Thea sinensis*** and remarked that he had seen some specimens with six petals and others with nine, but he left it to those who had the opportunity of studying the living plants to say whether that peculiarity denoted two or only one species. In the second edition of his work (published 1762) Linnæus discarded the name *T. sinensis* (without giving any reason) and accepted Hill's conclusion that there were two plants, which he named ***T. bohea***—the plant with six petals—and ***T. viridis***—the plant with nine petals. Linnæus then adds (still following Hill) that the leaves are longer in ***viridis*** than in ***bohea***, but he says nothing of Hill's contention that the former yields "green" and the latter "black tea." In the third edition of his work Linnæus made no alterations, but in the fourth (prepared by Willdenow, 1797) a few additional particulars are given (of the two forms above indicated) and ***T. bohea*** is referred to two varieties :—(*a*) ***laxa***—a plant with rough elliptic oblong leaves —and (*b*) ***stricta***—a plant with plane lanceolate leaves.

Only one Genus.

Supposed to be Two Species.

One Genus and One Species.

Seemann pointed out that on his own copy of the sixth edition of the *Genera Plantarum*, Linnæus had written certain corrections which show that the material then to hand had induced him once more to amend and amplify his description. Since then many botanists have striven to uphold the two Linnæan genera, their recognition being regarded as justified by certain trivial peculiarities of the calyx or, as Seemann affirms, of the stamens, but the final conclusion of the majority of writers, as already indicated, seems to be that they constitute but one genus and one species of tea. Engler and Prantl (*Pflanzenfam.*, 1895, iii., 6, 182-3), the most recent authors, reduce ***Camellia*** to ***Thea.*** and restore the rejected name ***Thea sinensis.*** But it would seem that that specific name cannot be given as a collective appellation for the many races of the cultivated tea plant, since it was rejected by Linnæus and, as Seemann points out, is geographically hardly correct. Long years ago Sims (*Bot. Mag.*, 1807, 998) recorded the conviction that there was but one species of tea, and further that ***Thea*** would have to be reduced to ***Camellia***. Link, however, accepted two forms of the tea plant, and called them ***Camellia Thea*** and ***C. viridis***, and thus reduced ***Thea*** to ***Camellia***.

Bohea.

The name ***Bohea*** is a corruption of Wu-i (Bu-i) mountains in Fuh-kien, long famous for Black Tea. According to Martyn (Miller, *Gard. Dict.*, 1807), Linnæus gave the name ***Camellia*** in honour of Kamel, a Moravian Jesuit, who collected plants in the Philippine Islands and sent them to Ray and Petiver between the years 1683 and 1700. The Abbé Berlese thinks, however, that the genus was named after an Italian, Father Camelli, who is said to have introduced ***C. japonica*** from Japan to Europe in 1739. Linnæus (*Hort. Cliff.*, 1737, 204) makes the interesting observation that although seven separate consignments of seed had been received at Clifford's garden in Holland, none had germinated, nor was he aware of any garden in Europe where the plant had been grown. Commenting on that statement, Breyn refers to J. Commelin (*Cat. Pl. Hort. Amstel.*, 1689, 346), who makes mention of the cultivation of the tea plant, but whether, adds Breyn, raised from seeds or live plants transported to Europe, he was unable to ascertain. This little episode brings to mind the repeated references to the sacred associations of the Chinese and Japanese with their tea industry and their unwillingness to furnish information regarding it. In fact the explanation of the failure to germinate the seeds may very probably have been due to the not unusual circumstance of these having been boiled before being allowed to be exported. Du Halde (*Gen. Hist. China* (Engl. transl.), 1736, iv., 21) speaks of tea as "another plant made use of in Physick." He then tells us that "the best tea grows in the middle of the trees which are most exposed to the sun." "The tea whose leaves are long and large is the best, on the contrary that which hath small short leaves is not esteemed good; that which hath its leaves curled is the most valuable, and that which hath them quite smooth is the worst." Here we have the practical man discussing the large- and small-leaved forms of the plant for which the botanist of that time invented names. But history is only repeating itself. Had the Indian planters considered these and other such passages they might have saved themselves the trouble and expense of introducing the small smooth-leaved Chinese plant, and taken at once to the large and bullate-leaved Assam indigenous.

Introduction to Europe.

Boiled Seed.

Best with Long and Large Leaves.

There are several cultivated and wild forms of ***Camellia***, but only the two that are of economic interest and, it might be said, of exceptional value to man, need be here dealt with:—

Garden Camellia.

1. **Camellia japonica** (including ***C. Sasanqua***). The Cultivated or Garden Camellia. This plant may be spoken of as a modern introduction to the gardens of Europe and India. It is accordingly not described by the early fathers on gardening. The year 1792 is generally mentioned as that of greatest interest in the history of the camellias, since all the better known kinds may be said to have appeared simultaneously about that time. For twenty to thirty years subsequently considerable interest was taken in their cultivation, and the number of forms, grown in hothouses, multiplied rapidly. But the great delay in their first arrival may be accounted for by the maritime struggles for supremacy in the Eastern trade, between the Portuguese, Dutch and Spanish, which culminated in their temporary expulsion from both Japan and China. To this same circumstance also is largely due the shroud of religious secrecy that opposed the development of the trade in—

The Tea Plant.

2. **C. Thea.** The Tea Plant; the *t'u* or *ch'a, she, theh* of the Chinese and *tsja, cha, ts-cha* of the Japanese—words which have practically accompanied the prepared leaves as tea, *te, tay, the, cha, chai*, etc., etc., into most of the languages of Europe and Asia. The English word tea was originally pronounced like the Chinese *te* or *tay*, hence Pope (*Rape of the Lock*, 1712) rhymes it with obey. It changed, however, very shortly after, since Edward Moore rhymes it (1750) with "Mrs. P."

Wild Plant.

Habitat.—Several writers report having met with the tea plant in a wild condition in certain parts of China and Cochin-China. It was discovered wild, or at all events completely acclimatised, in various parts of Assam by Bruce, Scott, Jenkins and Charlton, and the so-called indigenous habitats were examined by the "Tea Commission" and specially reported on by Griffith. In 1882 the wild tea plant was found by me as a forest tree or large bush in the eastern tracts of Manipur, and again, in 1894, was specially investigated in the Naga hills in connection with an effort to ascertain to what extent the pests and blights of the cultivated tea plant existed on the wild or acclimatised stocks. There would seem little doubt that it has been cultivated for several centuries at least, in Upper Burma and the Shan States, and doubtless may be wild in these countries also, though according to most observers it occurs in isolated spots, similar to those in the greater part of the Assam area; hence it could of course under these conditions be upheld as a survival of former cultivation rather than as manifesting a truly indigenous habitat. [*Cf. Agri. Ledg.*, 1896, No. 27.]

History.—Bretschneider (*Bot. Sin.*, 1892, ii., 20, 130–1) states that the tea plant is mentioned in the ancient Chinese Dictionary, the *Rh-ya*. It is there called *kia* and *k'u-tu* (*k'u* meaning bitter). He further explains that the Chinese character *T'u*, which has so many other meanings in the early Chinese classics, may, however, have specially meant tea. He then adds that the comparatively modern Chinese character *ch'a* arose through a confusion with that of *t'u*, somewhere between 202 B.C. and 25 A.D., but that it did not come into general use much before the 7th or 8th centuries. So in the same way the character *ming*, which would appear to denote the tea plant, occurs as *ming ts'ai* (= tea vegetable) in works written some centuries B.C. The Shans and Burmans to this day use pickled tea-leaves (see *Letpet* below) more as a vegetable relish than as a beverage, and it seems possible that this may have been the condition of use during the earliest classic times of China. We read that Wang Meng, father-in-law of the Emperor, in the middle of the 4th century, was fond of drinking tea, and set it before his friends, but they found it too bitter and generally declined, feigning indisposition. So again Bretschneider tells us that according to the *Ch'a-pu*—a special treatise on tea, published between the 10th and 13th centuries—the Emperor Wen-ti (589–605 A.D.) was recommended by a Buddhist priest to drink boiled *ming* leaves as a medicine for headache. It is somewhat curious that Kæmpfer relates a similar Japanese tradition that would seem to attribute the introduction of the plant to that country by Darma, the third son of an Indian king. But if the *t'u* of ancient Chinese classics be accepted as denoting tea, it may have originally been viewed as a medicine obtained from the plant known as *ming*, *ch'uan* and *kútú*. The habit of drinking a decoction of the specially prepared leaves, there would seem no doubt, is of comparatively modern origin. In the 8th century A.D. we have the first undoubted evidence of tea having become a regular industry, for in the annals of the Táng Dynasty we learn of its being subjected to an imperial duty. It was not regularly cultivated in Japan until the 13th century. That tea drinking in the rest of the world is quite a modern habit may be inferred from there being no classic names either for the plant, the prepared leaves or the beverage, in Japanese, Sanskrit, Arabic, Persian, Hebrew, Greek or Latin.

Chinese Records.

Vegetable Tea.

Use as a Beverage.

Imperial Duty.

Silence of Marco Polo.

Marco Polo, who travelled in China (in the tea districts of Fuh-kien) in the 13th century, makes no mention of tea, neither the plant, the vegetable nor the beverage, and yet it is well established that the plant and its properties were as fully known then as to-day. [*Cf.* ed. Yule, ii., 37–8, n.] But in passing it may be added that he similarly does not record having found the people in any part of his long travels drinking coffee. His omission to record tea is the more curious, however, since four centuries previously (9th century) the Muhammadan merchant Solaiman (according to Reinaud, *Relat. des Voy. faits par les Arabes et les Persians dans l'Inde et à la Chine*, 1845, i., 40) wrote, "The people of China are accustomed to use as a beverage an infusion of the plant, which they call *sakh*." "It is considered very wholesome. This plant (the leaves) is sold in all cities of the Empire." [*Cf.* Macpherson, *Hist. Europ. Comm. Ind.*, 1812, n. 130]. Ramusio (in the introduction to his edition of Marco Polo published in 1545) mentions having learned of the tea beverage from a Persian merchant, Hajji Muhammed. It was used all over the country of Cathay, where it was called *chiai*. In 1560, Gaspar da Cruz (in *Purchas' Pilgrimes*, iii., 180) refers to the porcelain used by the Chinese in presenting to their friends the beverage *cha*. Maffeius (*Hist. Indicarum* (*Select. Epist. ex Ind.*) 99), in a letter from Ludovic Almeida dated Nov. 1565, similarly says that it was the custom with the Japanese to show their friends with pleasure the pots, cups, etc., employed by them in drinking of a certain herb, reduced to powder, which was called *chia*. Maffeius (in the text of his work which was originally published in 1588) attributes the freedom of the Chinese from certain diseases (stone, etc.) to their habit of tea-drinking, and the Chinese (like the Japanese),

Tea-drinking in China and Japan.

he adds, take great pride in the teapots which they use in giving a friendly cup. Tulpius (*Observ. Medicæ*, 1641) extols the merits of tea as a medicine. It is somewhat significant that Garcia de Orta makes no mention of tea as one of the commodities brought from China and Japan to India. Linschoten (*Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, i., 157), who usually compiles from Garcia, practically repeats Maffeius's account of tea-drinking in Japan. Trigantius (*De Christ. Exp. in Sinas*, 1616, i., 68–9) speaks of the hot-tea drink of the Chinese. Casper Bauhin (*Pinax, Theat. Bot.*, 1623, 147) was apparently the first scientific or botanical writer who makes mention of what would appear to have been tea. But the passage in question does not occur in his earlier work (the *Phytopinax*, 1596). He calls it *chaa* and describes it as his seventh variety of *Fœniculum* (Fennel)! Absurd though this may seem there would appear to be no occasion to doubt that he is speaking of tea. Bontius, a Dutch physician resident in Batavia—(*Hist. Nat. et Med. Ind. Or.*, 1631, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 87)—tells us that his friend General Spex had removed all doubt as to the nature of the tea plant, since he had studied its cultivation in Japan. Bontius then goes on to say that the finer qualities of the decoction are often so bitter that sugar has to be added to make it palatable, and he compares the beverage to the "*cave*" (coffee) of the Muhammadans (see p. 364). He then urges that the difference between black and green tea is only in the method of preparation—a fact that took Europe nearly two centuries to accept. In Piso there is an excellent engraving of **Camellia Thea** (the Chinese form) drawn from nature in Japan by D. Caron, and presented to Piso; Caron went to Japan in 1638 under the Dutch E.I. Company. [Bretschneider, *Hist. Europ. Bot. Disc. in China*, 1898, 25.]

First Mention of Tea-drinking in India.

Albert de Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.*, 1662, 15, 18) says, "At our ordinary meetings every day we took onely *Thé*, which is commonly used all over the Indies, not onely among those of the Country but also among the Dutch and English, who take it as a drug. The Persians instead of *Thé* drink their *Kahwa*." This same statement occurs in Ovington's *Voyage to Suratt* (1689, 305–9, 427). It is curious, however, that in the *Ain-i-Akbari*, 1590, no mention is made of tea. It was conveyed to Europe by the Dutch East India Company, and from Holland was carried to England by Lord Arlington and others. In 1660 tea-drinking had become so general that it was taxed along with coffee, chocolate, etc., and sold at the coffee-houses. The English East India Company soon gave attention to it. In 1664 they made a present of some tea to King Charles II., and in 1677 the Company had taken steps to secure a regular supply. At this time tea sold in London at £5 to £10 a pound. A few years later (1689) a direct duty on imports (which amounted to 5*s.* a pound) was imposed. It is further noteworthy that at that time the East India Company drew its supplies for Europe *viâ* Madras and Surat and not direct from China. This circumstance would thus give an air of plausibility to the statement made by Mandelslo that tea was drunk in India about the same time, if not before, the habit had been originated in England. Evelyn (*Mem.*, 1690, ii., 20) speaks of having examined a specimen of the "roote of thea which was so perplexed large and intricate that it was wonderful to consider." Petiver (*Op. Hist. Nat.*, 1767, i., t. 21) shows a chair made of the roots of the tea plant which was presented by the "New East India Company" to Lord Somers. Curiously enough, one of the earliest and at the same time most instructive botanical specimens of the tea plant extant is in the Sloane Herbarium of the British Museum (lxxxi., f. 48). It belongs to a series of specimens said to have been collected in Malabar, between 1698 and 1702, by Samuel Browne and Edward Bulkley. Browne was a surgeon in the service of the East India Company, and died some time prior to 1703. He was succeeded by Bulkley. Both of these officers made extensive botanical collections, which were sent for the most part to James Petiver. It is just possible that long prior to the discovery of the indigenous tea plant in India or to the importations from China of seeds and plants accomplished by Gordon and Fortune (presently to be described), the tea plant had actually been conveyed to India and cultivated experimentally somewhere on the Malabar coast. But what is most curious of all is that the plant so grown was *not* **Camellia Thea**, *Link var.* **bohea** (the plant presently being cultivated most frequently in the plantations of South India), but *var.* **viridis**, and was thus very similar to the so-called "Assam Indigenous." It is, moreover, just possible that upon this very specimen was based the name **Thea viridis**, as given by Hill and adopted subsequently by Linnæus. In fact Linnæus pos-

Duty on Tea.

First Botanical Specimen.

sessed only one leaf of the plant, so that the type of the species has to be accepted as given by Hill (*Exot. Bot.*, *l.c.*).

Story of Black and Green Teas.

Chinese Plant in India.

Taxation of Tea.

It may now be useful to refer to a few recent writers and to thus carry the story nearer to the present time. John Coakley Lettsom, in the second edition of his splendid work, says that he agrees with Kæmpfer and Staunton in thinking that the question of green and black teas, as also the various qualities of these, is a matter of soil, age of leaf used and method of manufacture, and is not due to there being two botanically different plants. He gives, however, a coloured plate of the "Green Tea" plant and another of the "Bohea Tea." Both these are of course **C. Thea**, *Link*, but by Assam planters the former would doubtless be characterised as a hybrid, with linear-oblong bullated leaves (swollen between the veins), while the latter would be viewed as the typical so-called Chinese plant, with short ovate-oblong thick, smooth, dark-green leaves. It would thus seem that the finer tea plant of China was **Thea viridis**, *Linn.*, and formerly was, and probably still is to-day, not unlike the Assam indigenous; and hence very possibly stock of the most inferior qualities only was allowed to be exported to India. If this surmise be correct it is highly likely that but for the discovery in India of a superior indigenous plant, the establishment of the tea industry there might have been retarded by many years. At all events Indian planters regard the introduction of the so-called Chinese small-leaved plant as having been a calamity which it has taken them years of heavy expenditure to efface. It is somewhat significant that, while the question of the green and black teas has been thus for the second time satisfactorily disposed of, it should have been allowed once more to be revived, by certain subsequent writers, and to thus disfigure the literature of tea for a great many years. But to return to Lettsom's most valuable work. It is referred to several chapters and focuses in these all the practical information brought to light by the more trustworthy previous authors. The chapters are:—i. Authors on Tea (8–18), in which reference is made to 120 separate books or reports on tea that had appeared between 1565 and 1799 (most if not all these have been examined by me in preparing this article); ii. Origin of the Tea Plant (19); iii. Trade in Tea (24); iv. Soils and Method of Culture (26); v. Gathering the Leaves (29); vi. Method of Cutting (33); vii. Varieties of Tea Plant (38); viii. Ball or Brick-tea (40), etc. This brief abstract of some of the more important portions of Lettsom's book must suffice to indicate its great merit and historic value. Staunton (*Auth. Acc. Macartney, Embassy China*, 1798, i., 22; ii., 464) records the exports from China in English and foreign ships, 1776–95—a truly monumental work very largely drawn upon by Lettsom and others. The quantity is there shown fluctuating between 12 and 37 million pounds. The King's duty on Tea between September 1784 and March 1797 amounted to £4,832,189. Barrow (*Trav. China*, 1806, 572), who was Secretary to the Earl of Macartney of the British Embassy, practically continues the record given by Staunton, and many instructive particulars will be found in Milburn (*Or. Comm.*, 1813, ii., 520–42); Cooper, (*Trav. Pioneer Comm.*, 171); Murray (*China*, ii., 337); Macpherson (*l.c.* 128–32). From these and such-like works we learn that in 1703 the imports were 100,000 lb.; in 1721 they attained 1,000,000 lb., and for the hundred years 1710–1810 the aggregate sales by the East India Company amounted to 750,470,016 lb., valued at close on 130 million pounds sterling. In 1722–44 the duty was fixed at four shillings a pound excise, with in addition a customs' due of 14 per cent. on the average price. From 1784–95 the duty was gradually remitted until it fell to 12½ percent. Unfortunately in 1795 the old course of raising money by taxing tea was again resorted to and steadily augmented until in 1819 tea sustained a duty of 100 per cent. and in consequence the sales stood stationary at 21 million pounds. But by an Act of Parliament the East India Company's monopoly was abolished; unrestricted trade stimulated competition and reduced the price very greatly. At the same time the *duty was lowered to from 1s. 6d. to 3s. a pound according to quality.* In 1856 the duty became 1*s.*, in 1867 it was 6*d.* a pound, and in 1906, 5*d.* a pound.

Species and Varieties.

Species and Varieties of the Tea Plant.—In the first days of tea planting in India, though the presence of a wild tea plant was regarded as an indication of the suitability of the land, the wild plant itself was not viewed with favour as the stock to be employed. In fact, as already pointed out, the opinion was expressed most strongly by all or nearly all the experts of 1834–7 in favour of imported Chinese stock.

While that is so it may be said that for the past thirty or forty years the planters have deplored the day when the so-called Chinese tea plant was brought to India. At present no planter would for a moment dream of planting China tea, few would even grow the hybrid, while the majority would cultivate but one only of the several so-called indigenous stocks. The China plants imported in the early years of the industry still exist, however, and have furnished the seed for a considerable part of the present tea area. In consequence of the crossing of the Indian and Chinese plants there has come into existence the extensive series of so-called hybrids. Perhaps the clearest conception may, therefore, be obtained by an attempt to classify the forms, as near as may be possible, on botanical standards.

In a paper read by me before the Royal Horticultural Society (to which reference has already been made) I have given my views in some detail. Link (*l.c.* ii., 73) was the first botanist who definitely placed the tea plant under the genus ***Camellia***, and as already observed he recognised two forms, viz. ***C. Thea*** and ***C. viridis***. There would seem, however, no great advantage in regarding the forms indicated as anything more than varieties if not cultivated states of one species. Thus :—

Assam Tea.

Camellia Thea, *Link,* **Var.** (*a*) **viridis ;** *Thea viridis, Linn., Sp. Pl.*, 1762, 735; *Green Tea*, Lettsom, *Nat. Hist. Tea Tree*, 1799, pl. 1; *T. viridis, Hayne, Gewächse*, 1821, vii., pl. 29; Booth, *Trans. Hort. Soc. London*, 1830, vii., 558; *T. assamica, Masters, Journ. Agri.-Hort. Soc. Ind.*, iii., 1844, 63; *Assam Tea*, Wall., *Journ. As. Soc. Beng.*, 1835, iv., 48, pl. 2; *C.? Scottiana, Wall., Cat.*, 3668; Thistleton-Dyer, *Journ. Linn. Soc.*, 1873, xiii., 329; etc., etc.

Under this I assort the following races and cultivated states :—

1. **Assam Indigenous**—This has the mature leaf ranging from 6 to 7¾ inches in length, and from 2⅜ to 2⅞ inches in breadth. It contains about 16 veins on each side of the midrib. In passing it may be here observed that the value of the number and condition of the veins in the classification of the cultivated races of tea, was first pointed out in the *Pests and Blights of the Tea Plant* (ed. 1898, 15, 46–9). But there are numerous subraces of the Assam stock, such as the Singlo, Bazelona, etc. Collectively they are the most highly prized and most widely cultivated of all the Indian forms of the tea plant. It is, however, somewhat curious to read in Ovington's *Voyage to Suratt* (1689, 308) that three kinds of tea were in his time conveyed from China to India, namely, "Bing, Singlo and Bohe." This is apparently the first mention by a European writer of "Singlo," and the surmise naturally arises, how came that name to be given to one of the best of the Assam indigenous plants ?

Singlo.

2. **Lushai**—Sometimes called "Cachar Indigenous" or "Light-leaved Manipur." Under favourable conditions this forms the largest leaf of all the Indian tea plants. It has been measured from 12 to 14 by 7½ inches and recorded as possessing from 20 to 24 veins. It is not found wild outside the Lushai hills and South Cachar. It is a rather delicate plant and will not safely bear the hard pruning which may be given with impunity to other teas.

3. **Naga Tea**—This has a long, narrow leaf, generally from 6 to 9 by 2 to 3½ inches, with as a rule from 16 to 18 veins. It is very little cultivated except in one or two gardens on the borders of the Naga hills, such as Amguri, but is reported to be often used as a crossing stock.

4. **Manipur.**—This is the wild tea of the Native State of that name. It exists there purely and simply as a forest plant, the seed of which, but not the leaf, is valued. It is now grown fairly extensively in Cachar and some parts of Assam. It is a larger, coarser and broader-leaved plant than the Assam indigenous. The average mature leaf is from 6 to 8 inches in length and 2½ to 3½ inches in breadth and usually contains 22 veins.

5. **Burma and Shan**—Too little is known of these teas to allow of their critical separation from the Manipur plant. The leaves are smaller, thicker, more acutely serrated and distinctly more elliptic in shape than with the other teas. The plant in question has possibly been grown for centuries more as a vegetable than as a source of the beverage. This circumstance may be found to have produced properties with which we are at present not familiar. (See p. 235 under **Letpet.**)

6. **Yunnan and China.**—Fortune (*Three Years' Wanderings in China*, 1847, 68) speaks of the country south of the Yang-tse-Kiang as the region of Chinese ***T. viridis***, the tea being shipped from Shanghai and Ningpo. Crawford (*Journ. Emb. to Siam and Cochin-China*, 1830, ii., 264) speaks of the plant seen by him having leaves "twice or three times the size of that of Bohea tea."

Hybrid Tea of India.

Var. (β) **bohea**; *Thea bohea, Linn., l.c.* 734; Lettsom, *l.c.* 41; Hayne, *l.c.* vii., t. 28; *Bot. Mag.*, 1807, xxv., t. 998; etc., etc. The Bohea Tea of Fortune and others; the Hybrid Tea of Indian tea-planters.

Fortune (*l.c.* 197–224) found this as the chief plant in the great black-tea country of Fuh-kien, the tea which is shipped from Canton and Hongkong. It is a small-leaved plant with not more than 12 to 14 veins on either side of the midrib. It is freely admitted by planters to be a cross between ***viridis*** and ***stricta***, the plant presently to be indicated.

Chinese Tea of India.

Var. (γ) **stricta**; this is the form represented in the Linnæan Herbarium by a specimen, No. 1, but which bears no name nor any record. It is also the ***T. Chusan*** in Petiver (*Mus. Rar. Nat.*, 1695, n. 983, in Brit. Museum); ***Thea stricta***, *Hayne* (*l.c.*, 1821, vii., t. 27); Chinese Tea of the Indian tea-planters. This small bush may be seen in Indian seed-gardens flowering and fruiting freely, and though never pruned it preserves all its characteristics and rarely shows any departure toward *var.* ***viridis***. The leaves are thick and leathery, from $1\frac{1}{16}$ to $2\frac{1}{2}$ inches long, and vary from $\frac{1}{16}$ to $\frac{3}{4}$ inch in breadth. It has rarely ever more than 8 definite nerves, while ***viridis*** has 16 and ***bohea*** usually 12 to 14. It is essentially a bush, and even if given the chance it rarely if ever takes the poplar-tree form of the other races. No one has recorded the existence of this plant in a truly wild condition; and what is much more curious, it is more abundantly represented in herbaria as coming from India than from China.

Malacca Tea.

Var. (δ) **lasiocalyx**; *T. lasiocalyx, Planch., MS.*; *T. viridis, Wall., Cat.*, n. 979; *? ? C. axillaris, Roxb., MS.* (*Bot. Reg.*, t. 349, for description). This interesting form appears to have been met with alone in Malacca and Penang, and is perhaps the most tropical of all the forms of ***Camellia*** actually cultivated as tea. It seems probable that it may have originated by hybridisation with *var.* ***viridis*** some of the better known forms of tea, such as *var.* ***stricta***. In this light the suggestion above made that it may be the plant Roxburgh designated as ***C. axillaris*** becomes of more than botanical interest. At all events both the locality and description given by Roxburgh suit *var.* ***lasiocalyx*** to a remarkable degree. This is the plant seen by Griffith at Pringett near Malacca.

In order to obtain the true value of the characters above indicated that are dependent on the veins of the leaves, it is necessary to examine the shoots which spring directly from old wood, that is to say, shoots low down on the stem. Of the Manipur and Assam plants—those in most favour in India at present—it may be said that the former is much more hardy than the latter and should accordingly be used wherever liability to drought exists. The Assam gives, however, a thinner and more delicate leaf with more flavour, and the value of the tea made from it is decidedly greater. All hybrids, so Dr. Harold H. Mann affirms, should be avoided; in other words, all plants that show from 10 to 14 veins—the intermediates between *var.* ***viridis*** and ***stricta***. [*Cf. Pests and Blights* (1st ed.), 42–50; Mann, *Factors Deter. Quality of Tea, Ind. Tea. Assoc.*, 1907, No. 4.]

EARLY ENDEAVOURS IN INDIAN TEA-PLANTING.

Early Endeavours.

Discovery of Tea Plant in India.—Difficulties having arisen with China, the British Government realised the danger of having no other source of tea supply than China. They accordingly interested the East India Company in an effort to produce tea in India. Sir Joseph Banks, in 1788, recommended Warren Hastings to attempt its cultivation in Bihar, Rangpur or Kuch Bihar. It appears to have been discovered in Assam, perhaps originally by Major Bruce, subsequently in Manipur by Mr. Scott, somewhere between 1821 and 1826, but little attention was paid to that circumstance until some years later. Lord William Bentinck, Governor-General of India, in a Resolution dated January 24, 1834, warmly took up the matter of Indian tea cultivation. A Committee was appointed by him, with Dr. N. Wallich as Secretary, to report on the most hopeful situations for an experimental cultivation. Mr. G. J. Gordon, of the firm of Mackintosh & Co., was dispatched to China to procure seed, to collect information, and to bring to India Chinese cultivators. He was, however, shortly after recalled because wild tea had been re-discovered by Jenkins and Charlton in Assam. But had Bruce and

Introduction of Tea Plant.

Discovery in India.

Appointment of a Commission.

Black and Green Teas.

Scott's discoveries received the attention they deserved, Gordon very possibly would never have been sent to China. As it was, Wallich refused to believe that even Jenkins's plant was the true tea plant until he had a sample of tea made from it and sent to him. In due time a Commission was appointed to visit Assam in order to report on the discovery of Indian indigenous tea. It consisted of Drs. Wallich, Griffith and McClelland. They could not agree as to the plant, but for the purpose of the Government experiments recommended that the Himalaya should be first tried, then Assam, and lastly the mountains of South India. They then added that "the China plant and not the degraded Assam plant" should be experimented with. The controversy about black and green tea and of the separate plants from which these were supposed to be made was doubtless the will-o'-the-wisp that largely influenced Wallich to lay down the dictum that the Indian plant was a ***Camellia*** and not a ***Thea***—a distinction, as has been shown, without a difference, and one which greatly retarded the Indian tea industry. Unfortunately for Wallich his so-called ***Camellia*** has since proved very much more valuable than the ***Thea***, the merits of which he extolled and which alone, in his opinion, should have been cultivated. It may be here added that it is remarkable, when so much difference of opinion prevailed and the existence of wild tea in Assam had even been challenged, that no one thought of drawing attention to the specimen of the tea plant from Malabar preserved in the Sloane Herbarium. Had this been done, we should in all probability have been told the history of that sample more definitely than we are ever likely now to learn, and at the same time a fuller conception of the Chinese tea plant would have been obtained than possessed by Wallich and others, who denied that the Assam stock was the true tea-yielding species.

Different Opinions as to Location.

Missions to China.

Wallich, Royle and Falconer (*Journ. As. Soc., Beng.*, 1834, iii., 178–88) upheld the Himalaya as the preferable locality, while Griffith and McClelland urged the claims of Assam, which they regarded as the indigenous habitat of the plant. In guarded yet unmistakable language Griffith gave his opinions, even though these were inimical to the views of his superior and colleague, Dr. Wallich. Gordon was in consequence re-deputed to China, and on his return to India with a supply of plants, seeds, etc., he resigned his connection with the Commission without having written an account of his journeys in China. A third mission to China (the expenses of which were partly borne by the Royal Horticultural Society of England) was organised and successfully conducted by Mr. R. Fortune, who wrote in consequence, *Three Years' Wanderings in China* (1847), *Tea Districts of China* (1852), and *A Residence Among the Chinese* (1857). These works contain full particulars of his studies of the Chinese industry, as also details regarding the plants, seeds, etc., conveyed by him to India.

Continuing this brief sketch, it may be added that in India itself a number of books and reports on tea appeared in rapid succession, from about the date of the Tea Commission's report. [*Cf.* Griffith, *Rept. of Tea Plant in Upper Assam*, 1835; C. A. Bruce, *Rept. Manuf. Tea and Tea Plantat. in Assam*, in *Edinb. New Phil. Journ.*, 1840, xxviii., 126–61; also *Acc. Manuf. Black Tea*, 1838; Robinson, *Assam*, 1841, 127–8; Charleton, *Corresp. regard. Disc. Tea in Assam*, 1841; Royle, *Tea in Himal.*, *Prod. Res. Ind.*, 1840, 257–311; Jameson, *Tea in Kangra*, 1853; also *Rept. Govt. Tea Plantat.*, in *Journ. Agri.-Hort. Soc. Ind.*, vi., 81; Wingrove, *Assam Tea*, 1870; Cochran, *Ind. Tea*, 1872; Campbell, *Profit. Cult. Tea*, in *Journ. Soc. Arts*, 1872; Money, *Cult. and Manuf. of Tea* (1st ed.), 1874; Claud Bald, *Ind. Tea, its Cult. and Manuf.*, 1903; Bamber, *Chem. and Agri. of Tea*, 1893; also *Rept.*

on Ceylon Tea Soils, Colombo, 1900; Schulte im Hofe, *Tropenpflanzer*, 1901, ii. (*Beih.*), 37-117.] These may, therefore, be viewed as amplifying the citation of more or less botanical publications mentioned in the opening paragraph. But it is essential to mention still two other works, viz:—(*a*) Bretschneider's *History of European Botanical Discoveries in China*—a truly stupendous volume which reviews and indeed often quotes very fully most of the scientific authors who have written on the Chinese Tea Plant. And lastly (*b*) Prof. J. J. Rein's *Industries of Japan*, 1889, which gives a delightful sketch of the early history and modern development of the industry in that country.

Numerous reports were issued by the Government of India, from the date of the appointment of Mr. C. A. Bruce in 1836, as Superintendent of their Assam plantations, to the time when they ceased in 1865 to have any direct interest in tea. These made public the discoveries accomplished and the experience gained. It had been freely announced that when the industry no longer required the fostering care of Government, it would be handed over to private enterprise. The progress in Assam was such that long before Government could resign their Himalayan plantations they had retired from Assam. It may be here mentioned that the first sample of Assam-made tea was sent to England in 1838. From that date the progress was rapid. The other day, while examining the numerous papers on tea preserved in the India Office, I came across what purports to have been the first fly-leaf of a commercial sale of tea made by Government. It is signed by Mr. Thos. Watkins, Superintendent of the Government Plantations, and endorsed by N. Wallich, M.D., Superintendent H.C. Botanic Gardens. It is dated Jaipur, Upper Assam, March 5, 1841, and headed, "A Novel and Interesting Sale of Assam Teas—the First Importation into the Calcutta Market." That circular (reproduced, *Journ. Roy. Hort. Soc.*, 1907, xxxii., 69) announces, in fact, two parcels of tea offered for sale, namely thirty chests manufactured by the Singhfo chief Ningroolla, and ninety-five the produce of the Government tea plantations. It may thus be noted that the Singhfos were actually manufacturing tea in Assam at the very time apparently that Wallich challenged the production of tea as the evidence necessary to convince him that the Assam indigenous plant was the true tea-yielding species.

Retirement of Government of India from the Industry.

First Sales.

First Public Tea Gardens.—The Sibsagar (Jaipur) plantations of the Government were sold in 1840 to the Assam Company—the first tea concern, and to this day very much the largest Company in India. It was anything but prosperous during the first 15 years of its existence, and its shares fell so low that they could hardly be sold. But about 1852 it began to improve, and with that success the tea industry appeared so promising and attractive that speculators eagerly rushed into it. The discovery of the indigenous tea in Sylhet and Cachar gave the impetus for an expansion of the industry into the Surma valley, and in a few years thereafter the whole of the upper portions of the province of Assam (both the Brahmaptura and Surma valleys) might be described as converted into a huge tea plantation. About this time (1853-5) tea-planting was organised in Darjeeling, and shortly after followed Chittagong, Chota Nagpur and the Duras. Ultimately tea cultivation spread over every district of India where there was the least hope of success, but with a rapidity that was certain to culminate as it did in the great disaster of 1865-7. It is needless to dwell on the causes of that disaster, but the reader is referred to Mr. (afterwards Sir) John Ware-Edgar's full report. It was, briefly, a natural consequence of reckless impetuosity, ignorant supervision and positive dishonesty. Fortunes were made by the few who realised that the tide

Assam Plantations.

Cachar and Sylhet Plantations.

Darjeeling Plantations.

Disaster, 1865-7.

would turn. The better situated gardens were purchased for fewer rupees than they had cost pounds sterling to construct. New companies were formed to work these and with the avowed purpose of growing tea for its own merits, as a commercial article, and not for the purpose of selling gardens at a profit. Out of these trying times the industry rose on a firmer foundation, and the subsequent prosperity is one of the marvels of modern commerce.

Marvellous Prosperity.

It is not known how much money the Government of India actually spent, from first to last, in their efforts to ingraft the tea industry on India, but it would appear that Gordon's missions to China and the expenditure of the Indian Tea Commission came to close on £18,000. If we assume that sum to have represented but one quarter of the total expenditure actually incurred, the result might still in perfect fairness be characterised as one of the most profitable undertakings of the Administration of the Empire of India. There has been organised a new industry the value of which may be judged of from the following circumstances :—Tea now occupies half a million acres of land formerly waste, and of this 64 per cent. are in the province of Assam : the industry now gives lucrative employment to close on 600,000 persons : the capital invested in it comes to well over £20,000,000 : the first exports (1838) amounted to 488 lb., and in 1904 they stood at 200 million pounds valued at, say, £6,000,000 : still further, it may be claimed that, as an offshoot of the Indian industry, Ceylon has been saved from absolute bankruptcy by the substitution of tea for coffee : and lastly that India and Ceylon have given to England a regular supply of a much purer and infinitely cheaper article than it formerly received from China (see p. 240).

Value of the Tea Industry

CULTIVATION OF TEA.

Cultivation.

(*Contributed by* HAROLD H. MANN, D.SC., *Scientific Officer to the Indian Tea Association*, pp. 218–39).

Object.—The object to be attained in tea-planting is the production on the tea plants of a constant succession of young shoots throughout the season. The youngest leaves on each shoot only are capable of being made into tea, and hence it is easy to see that the growth of tea occupies a unique position among agricultural industries. Few of these concern themselves, except indirectly, in the production of leaf : still fewer limit the crop on a perennial plant to the youngest shoots. To obtain the results needed, the methods applied have a very special character, which has made tea-planting one of the most technical of those industries which depend on the culture of the land.

Features of Planting.

Past Failures.

Past Failures.—The first years of tea-planting in India were, for the reason just indicated, almost a hopeless failure. A very small crop was obtained, the leaf was plucked when too old, and a large part of the tea was hence all but unsaleable, and the early planters had to buy very dearly the experience which has made the tea industry such a great and profitable speculation. In Assam, till 1848, continual losses occurred ; from that time for the next four or five years the Assam Company, the pioneer and only company in the province, just succeeded in paying its way ; thereafter, tea culture became exceedingly profitable, and if checks were received, such as the memorable panic of 1866, it was not owing to the character of tea culture, but rather to financial dealings in Calcutta and in England, coupled with certain fraudulent operations on the spot. Though tea culture has been a profitable industry since 1853, yet the

Continuous Improvement.

methods adopted have been continually improved. So far as the plants are concerned, the methods of pruning, of plucking, of cultivation in general, have constantly been ameliorated, and the improvement is still going on. The result is shown in the increase of crop; in 1873 the crop in Assam was roughly from 250 to 280 lb. per acre, and in 1904–5, in Assam, Cachar, Sylhet and the Duars, it ranged between 450 and 500 lb. per acre, and, as a rule, the leaf plucked was finer and more capable of making good tea than at the earlier date. The manufacture of the leaf has undergone a total revolution; the rolling by hand, as also the drying or firing over charcoal (and the attendant evils and risks of these methods) have been entirely abandoned. Since the introduction of the first feeble efforts at manufacture by machinery in the early 'sixties, stage by stage the older methods have disappeared, and now the work in a tea-factory is or can be made, in a very large measure, an automatic process.

Improved Yield of Superior Quality.

Space cannot be afforded to trace the development of tea culture and manufacture in India from the earliest to the latest stages, interesting though such a story would be: all that can be attempted here is to state the most approved conditions for the culture of the tea plant, to describe the methods adopted in planting and maintaining an estate, and to give some account of the principles of manufacture at present in vogue.

Selection of Localities.

Localities and Climates.—The most suitable localities for the culture of tea have been, from the beginning, a source of fruitful discussion. Already in 1836, of the men best qualified to judge, some maintained that the North-West Himalaya with a temperate climate and occasional frost would be found the ideal situation: others, that Assam, where the plant had been found apparently indigenous, possessed conditions very similar to those of the best tea districts of China: while the equable climate of the Nilgiris was also recommended. Truth to tell, there were elements of vantage in all these localities. The ideal tea climate, however, is probably that of Upper Assam, and perhaps of Cachar—those districts, in fact, where the apparently indigenous tea had been discovered. The hilly colder districts of Darjeeling, Kumaon, the Nilgiris and of the Kangra Valley have produced very successful plantations, but in all these the crop per acre is very considerably smaller than that of Upper Assam, though this smallness of crop is often (though not always) compensated for by an increase in quality in the tea. On the other hand, very satisfactory results have been achieved in the hotter and drier districts of Lower Assam, of Sylhet, and in a less measure of Chittagong; but here the tea produced has always been inferior in character. Tea requires, in fact, neither a tropical nor a temperate climate, but a subtropical one, with a fairly moist atmosphere throughout at least the greater part of the year. In point of temperature the best growth is produced with a daily variation of temperature, say, from 75° to 85° F. If it goes far above the latter point, damage results, unless the high temperature is accompanied by very moist conditions: the highest shade temperature usually reached in Upper Assam is from 95° F. to 98° F., and this always during the rainy season. Only very slow growth, on the other hand, takes place much below 70° F., and though plucking continues in many districts when the daily maximum does not reach this point, yet the intervals between the crops of leaf become very long. During part of the year, almost all over the Indian tea area, no plucking is attempted, and then the temperature may go down almost to freezing

Temperature.

Frost.
Rainfall.

point without damage. Frost, however, always blackens the leaves, and, if severe, damages the younger twigs on the bush. As to rainfall, the distribution is of more importance than the amount. Sixty inches per annum, well distributed, is ample. The best Indian tea areas receive about one hundred inches, though there are many on which a much greater amount falls. This rainfall should, however, occur, as far as possible, throughout the year. A long drought, at any season, is fatal, and this fact has had a good deal to do with the comparative failure of both Chittagong and Chota Nagpur as tea districts.

Situation and Soils.
Hills *versus* Plains.
Expo

Situation and Soil.—Equally important with the climate in determining the suitability or otherwise of a locality for tea culture is the character of the situation and of the soil. Early in the history of Indian tea there was a considerable prejudice, doubtless drawn from the accounts of Chinese travellers, in favour of planting on hills or steep slopes. But there was really nothing in the preference: if the soil is suitable, it is better on flat than on sloping land, especially if the latter faces south or south-west; if the land is not suitable, it is certainly no more so on a hillside than on the level. Nowadays it is recognised that the flatter the land the better, other things being equal.

Soils to be avoided.

There are two points in connection with the physical texture of the soil which are essential, if tea is to be successfully grown. It must *first* be well drained, and *secondly* it must be easily penetrable by the tea-roots. A hard and waterlogged soil are equally fatal to successful tea culture: in the former case the bushes cease to yield, and become the prey of disease; in the latter they die out. It may be said that tea will grow in almost any soil provided it be well drained, but it flourishes best in a light, sandy, deep loam. If the physical texture of a clayey soil is such as to give it the porous and soft character required (as is often the case in South India and in a large area in the Duars), it may form excellent land for tea culture. There are two classes of soil specially to be avoided: first a stiff clay, of any kind or colour, impervious to rain and which cakes or hardens in the sun: and second a very loose soil overlying gravel, which in the absence of regular and very constant rain will ultimately produce a stunted bush yielding little leaf. Wherever the land is deep, moist, fairly porous, well drained or drainable at all seasons, and with a sufficiency of plant-food, the tea is likely to do well, so far as soil conditions are concerned.

Virgin Soil.
Composition.

Chemically, tea demands a rich soil, and has usually, except in the south (where old coffee land has been employed), been planted on virgin soil, either forest or grass land being utilised for the purpose. Where the attempt has been made to put it out on soil previously used for the cultivation of sugar-cane or cotton, it has almost uniformly grown very badly. It refuses to flourish where houses have long stood, even though the soil may be quite rich, but this is possibly largely due to the hardening and compacting of the soil. Exception being made of special conditions such as that just described, and provided the physical character of the land is equally good, the luxuriance of tea seems to vary directly with the amount of organic matter and nitrogen in the soil. In virgin soils these two constituents seem, in India, to be closely proportioned to one another. Excess of vegetable matter leads to the production of a large crop of weak, watery tea without flavour; on the other hand, a soil deficient in these constituents produces only a small crop, and, moreover, the plants will almost certainly be attacked by blights at an early age. Much controversy has arisen as to the cause of flavour in the tea, produced from certain soils, notably those of Darjeeling, and it now seems, most probably, to be connected closely with the presence of relatively large quantities of phosphoric acid and potash in the land. Other causes complicate the question, but it is almost certain that the mineral plant-food constituents hold a very important relationship to flavour. The presence of more than a very small quantity of lime in a soil seems almost fatal to successful tea culture : the average amount present in India is under 0·2 per cent.

Relation of Flavour to Soil.

CHEMICAL CHARACTERISTICS OF TEA SOILS.—***Assam.***—The soils actually under tea culture at present in India are of very great variety. In the Brahmaptura valley (Assam), while all the tea land is alluvium, the best results have been obtained on fairly light, red, rather coarse sand or silt, or on the stiffer, older, and redder alluvium which forms small plateaux in certain districts (Tezpur, Bishnath). The following are typical analyses, the samples having been taken from the surface to 15 inches deep :—

Assam.

—	Virgin Grass Land, Upper Assam.	Virgin Forest Land, Upper Assam.	Virgin Bamboo Forest Land, Upper Assam.	Virgin Forest Land, Upper Assam.	Older Alluvial Plateau Land, Assam.
Organic Matter, etc.	6·75	5·75	3·76	2·87	7·40
Oxide of Iron ..	2·95	3·11	1·72	0·91	5·03
Alumina	5·74	6·95	3·29	2·13	10·77
Lime	0·09	0·11	0·06	0·04	0·09
Magnesia	0·72	0·74	0·47	0·18	0·52
Potash	0·38	0·26	0·16	0·10	0·58
Soda	0·19	0·28	0·24	0·02	0·18
Phosphoric Acid ..	0·08	0·06	0·05	0·03	0·05
Insoluble Silicates	83·10	82·74	90·25	93·72	75·38
	100·00	100·00	100·00	100·00	100·00
Nitrogen	0·14	0·12	0·09	0·09	0·13

Cachar and Sylhet.—The tea in the Surma valley (Cachar and Sylhet) was originally planted almost entirely on small hills (*teelas*) which occur over almost all these districts, and which were surrounded by low-lying flat land, often swamp. Much of this low land was in later years found to be perfectly capable of drainage, and when drained formed very rich beds, sometimes of peat, sometimes of black soil highly charged with organic matter. Tea has been found to flourish exceedingly on these so-called "*bheel*" soils, which produce enormous crops of low-quality tea. In Sylhet in addition to these types of land, much tea has been planted on plateau land very similar to that in the Brahmaputra valley. The "*teela*" and "*bheel*" soils of Cachar and Sylhet are typified in the following analyses:—

Cachar and Sylhet.

—	Virgin "*Teela*" soil, Cachar.	"*Teela*" soil, Cachar.	Peat "*Bheel*" soil, Sylhet.	Peat "*Bheel*" soil, Cachar.	"*Bheel*" soil, Cachar.
Organic Matter, etc.	10·15	5·33	51·76	40·56	15·92
Oxide of Iron ..	5·19	2·90	0·95	1·26	3·52
Alumina	4·34	6·06	5·84	11·57	9·68
Lime	0·09	0·06	0·10	0·07	0·21
Magnesia	0·72	0·33	0·28	0·34	1·14
Potash	0·50	0·32	0·31	0·58	0·79
Soda	0·22	0·14	0·21	0·20	0·27
Phosphoric Acid	0·11	0·06	0·26	0·25	0·12
Insoluble Silicates	78·68	84·80	40·29	45·17	68·35
	100·00	100·00	100·00	100·00	100·00
Nitrogen	0·21	0·12	2·37	1·17	0·44

The tea land of ***Chittagong*** resembles that in Sylhet.

Duars and Darjeeling.

Duars, Terai and Darjeeling.—The Duars and Terai, districts lying in a strip 10 miles or more wide at the foot of the Himalaya, south from Sikkim and Bhutan, contain soils of several types. The most characteristic is, however, a huge bank of stiff and yet porous red soil on which lie some of the most successful tea estates in India. In Darjeeling the land differs from the foregoing in not being alluvium, but formed *in situ* from the rocks of the districts. It is a clayey and yet highly porous soil, which is rich in mineral plant-food constituents. The following are analyses of type soils from the Duars and Darjeeling:—

	Red Bank soil, Duars.	Red Bank soil, Duars.	Darjeeling Soil.	Darjeeling Soil.
Organic Matter, etc. .	8·73	11·61	11·78	9·32
Oxide of Iron .. .	6·27	6·92	7·64	—
Alumina	10·96	11·92	11·78	11·98
Lime	0·10	0·02	0·40	0·15
Magnesia	1·16	0·81	0·91	0·68
Potash	0·76	0·77	0·87	0·65
Soda	0·18	0·34	0·23	0·13
Phosphoric Acid .. .	0·16	0·11	0·12	0·11
Insoluble Silicates .. .	71·68	67·50	66·27	76·98
	100·00	100·00	100·00	100·00
Nitrogen..	0·20	0·26	0·15	0·23

South India.

South India.—The soils of the remainder of the districts of North India hardly call for remark. Those of the south country—the Nilgiris, Travancore and the Wynaad—are as a whole characterised by a large proportion of clay, and yet by a very granular texture. They are all hill soils probably formed *in situ*. The analyses (due to Bamber) of two fairly typical soils from Travanc are shown below:—

—	Travancore Tea Soil.	Travancore Tea Soil.
Moisture	8·60	10·00
Organic Matter, etc.	16·20	12·00
Oxide of Iron	8·40	10·00
Alumina	13·99	16·02
Lime	0·12	0·46
Magnesia	0·56	1·04
Potash	0·11	0·46
Phosphoric Acid	0·02	0·02
Insoluble Silicates and Sand ..	52·00	50·00
	100·00	100·00
Nitrogen	0·36	0·16

Propagation.

PROPAGATION.—The tea plant is invariably grown from seed. Attempts to propagate on a large scale from cuttings or by layerings have never been very successful. It is difficult, in fact, to get the cuttings to strike, and the method of layering does not allow of rapid enough increase of plants to be ever used. The real reason, however, of the avoidance of these methods is the ease with which plants are grown from seed; and for supply of seed, special bushes or even special seed-gardens are reserved.

Flowering.

Seed.—Plants used for seed-production are allowed to grow naturally, without any pruning. They thus form trees up to 30 or even 40 feet high, more or less resembling a poplar in shape. The "*China*" plant is, however, an exception, and rarely grows to a height of more than 10 or 12 feet. All the forms flower in North India from September, and the fruits take a year to come to maturity. A second small lot of flowers often

Seeding.

forms in February and March. The seed is procurable about November, collected in the latter half of October, and packed for transmission in almost dry soil. A box containing 40 lb. of shelled seed will usually weigh from 120 to 180 lb. The seed does not keep well, and ought to be sown as soon as possible after being plucked. It has often been upheld that the seeds being rich in oil might be systematically collected and sold by the planters as an additional source of revenue.

Nurseries.

Selection of Site.

Nurseries.—The sowing is now almost universally made in nurseries. The seed, sometimes previously germinated, is deposited at either 4 or 6 inches apart and 1 inch deep. A piece of particularly good land is chosen, and formed into beds from 3 to 5 feet wide. Such a nursery must be well drained and very careful attention given to the preparation of the soil, which should be raked as for a flower-bed. If previously under tea culture, the land must be richly manured with cattle-dung. If the situation is hot and dry, the beds should be covered with grass immediately after sowing; in any case water must be accessible for watering the nurseries. Forty pounds of seed may be expected to give about 10,000 plants, and will put about 2 to 2½ acres of land under tea. As soon as the young plants are visible above the surface, the beds should be shaded by raised frames covered with grass or mats, be frequently weeded, and, if the weather be dry, watered in the evenings. As a rule, the plants sown in the nursery in November or December can be planted out in the following May or June (six months old planting), or when a year old in the following November or December.

Preparation of Land.

Preparation of Land.—In order to ensure a good result, it is necessary to bestow much care on the preparation of land for tea. If it has previously been under forest, the whole of the trees should be cut down, the stumps removed as far as possible (since many of them are liable to cause root disease in the tea), and the land hoed carefully all over. If grass land is to be planted, the roots should be carefully removed when the land is being hoed up. If hillsides are to be put out, it is advisable to arrange before planting for terraces, running along the contour of the slopes. If stones exist in the soil, they should be brought to the surface and utilised in making the terraces. On level land the lines of drainage should be arranged, and, where necessary, narrow drains, 3 feet deep, put in before planting out the tea.

Terracing and Draining.

Transplanting.

Planting Out.—These arrangements having been completed, planting can be commenced. In order to secure regularity, lines must be marked out and the seedlings placed at definite distances apart along these lines. What these distances should be varies with the type of plant, the richness of the land, and the method of planting. Speaking generally it is not wise to put the plants nearer than 4 feet apart in any direction, nor wider than 5 feet apart. If planted in rows at right angles to one another (square planting), this means in the one case 2,722 and on the other 1,742 plants per acre. Four and a half feet apart is perhaps the most generally advisable, equal to a little over 2,000 plants per acre. In recent years it has become usual to plant in rows at an angle of 60 degrees to one another (triangular planting), thus making the plants equi-distant from each other. In this case a distance of 5 feet between the bushes gives a number of plants per acre about equal to that obtained at 4½ feet apart in square planting, and is thus to be preferred. When the spacing and condition have been decided upon, lines should be formed, and stakes

Lining the Plantation.

Plants to Acre.

placed at definite distances on these lines, to mark where holes are to be dug and the plants to be placed. Prior to planting out a hole should be dug at each of the stakes at least a foot deep and 10 inches wide, and the young plants then removed from the nursery and deposited in the prepared holes.

Period.

Method.

Period of Transplanting.—Planting may be done either when the seedlings are 6 months old or when they have been in the nursery for a year. Under ordinary circumstances 6-months planting is gradually being more and more adopted. Under this system the plants are taken from the nursery when 4 to 8 inches high, and have a small ball of earth 6 to 8 inches deep attached. They are conveyed to the holes which have been made ready, as above described, but if the ends of the tap-roots are seen protruding or bent they are either straightened or nipped off. Each ball of earth with its plant is then placed in the centre of a hole, loose earth filled in all round, and rammed down moderately. If the rain follows immediately the only attention required afterwards will be to see that weeds are cleared all round the plants, and that the surface earth is kept loose. If rain does not come at once, the plants will need watering. If planting be done with older seedlings in November or December it is necessary to have a very much larger block of earth (at least 12 inches deep and 6 inches in diameter) attached to the root, and correspondingly larger holes in which the seedlings are to be deposited. In this case, as the planting takes place in the dry weather, a considerable quantity of water should be given, and a mulch of dry grass placed around the plants.

Rules.

In planting, according to one of the best and most recent authorities (C. Bald, *Ind. Tea, its Culture and Manuf.*, Calcutta, 1903, 69), the following rules should be observed, viz.:—

"(*a*) The end of tap-root may be cut clean off, but it must not be bent or doubled up.

"(*b*) The plant must be placed so that the *collar* is level with the surface of the ground. If placed too high, some of the roots will be exposed; if too deep, the bark of the stem will be injured by being buried. The plant should be at the same depth in the ground as it was in the nursery.

"(*c*) The laterals should be spread out, not driven into a clump round the tap.

"The hole should be only one-third filled with earth, which is then pressed round the plant by hand; one-third more filled and trodden or rammed moderately, and the remaining third filled in but left quite loose."

Drainage.

Nature and Direction of.

Drainage.—Mention has already been made of the necessity for drainage on most tea soils. On the flat or nearly flat land, the drains should be at least 3 feet deep, as narrow as possible, banked up a little on the sides to prevent the water running off the surface into the drains, and should follow the natural course of the drainage of the land. For ordinary tea-soils they should be from 30 to 60 feet apart. On slopes the object of the drains is not only to cause percolation of the water, but also to prevent wash of soil. They should hence run along the contour of the land, and be slightly banked up on the upper side. At intervals, main drains (running down the slope and thus crossing the contour drains) will be required to carry away the water. [*Cf.* Mann, *Treat. Deter. Tea in Ind., Tea Assoc.*, 1906, No. 4, 8–12.]

Hoeing.

Hoeing.—In all the districts of Northern India it is found that careful hoeing of the land is needed from the early days of the plantation, both in order to prevent the growth of weeds and to keep the surface of the land loose. With young plants the principal cultivation (apart from keeping the weeds down) is done by frequent loosening of the soil to a depth of 3 inches and for a distance of 12 inches round the bushes. Among tea more than 2 years old, the following hoeings may be said to be usually required:—

Number of Hoeings.

(*a*) A deep hoeing at the commencement of the annual dry weather —at least 8 inches deep—should be given. This preserves the moisture in the lower layers of the land, during the drought which follows, as well as softens the soil and thus prevents the formation of a hard pan near the surface.

(*b*) From 4 to 6 light hoeings per annum. Each of these loosens the soil to a depth of about 4 inches. They should take place at intervals of about 6 weeks.

In South India and Ceylon, owing to the extremely granular character of the soils, and to the fact that there is no long season of drought such as is experienced in Northern India, much less cultivation of the land is done than that above recommended, the hoeing being replaced in a great measure by hand-weeding.

Manuring.

Farmyard Manures.

Chemical Manures.

Manure.—Manuring is not usually needed for some years after a plantation is started. Nitrogenous fertilisers are then principally required, best in the form of organic manures, and nothing is better than cattle manure, if it can be obtained. The cattle manure generally to be had in India is extremely poor, and so twenty tons per acre would not be an excessive dressing. Little more than a third of that quantity of good stall-fed dung would be of equal value. With the cattle manure all the waste materials of the tea estate, such as the wood-ashes (if wood is burnt in the factory), the thatch, the sweepings from houses, etc., are mixed and heaped together in special manure sheds and thus made ready for use. This so-called cattle manure is best applied early in the year, before the first hoeing of the season. In default of cattle manure, oilcake—usually from castor or rape seed—has given the best results, and is now used largely both in the districts of North and South India. It is commonly applied broadcast, at the rate of about half a ton per acre. In Ceylon a good deal of artificial manure—chiefly superphosphate and basic slag with or without sulphate of potash—has been and is being used, but the application of such manures has been elsewhere on a very limited scale. [*Cf. Pests and Blights, etc.*, 119–34; Mann and Hutchinson, *Heeleaka Exp. St., Assam*, in *Ind. Tea Assoc.*, 1907, No. 2.]

Green Manures.

Shade-trees.

In recent years very good results have been obtained by green manuring. The plant chiefly employed in North India has hitherto been ***Phaseolus Mungo,*** which is sown broadcast in April or May at the rate of 40 lb. of seed per acre, and is hoed into the land after 6 to 8 weeks. Other plants have been suggested for the purpose, and from recent experiments it seems probable that good results may be obtained with ***Crotalaria striata*** and ***Sesbania cannabina.*** In Ceylon the best returns have been given by the use of ***Crotalaria striata*** as a green manuring crop, but the ground-nut (***Arachis hypogæa***) has also been employed. Stumps of the *dadap* tree (***Erythrina lithosperma***) have been planted and the growth periodically pruned off and buried. It is essential, however, that the stumps should not remain in the tea for more than one year, as otherwise they are very apt to cause stump-rot, due to the fungus ***Rosellinia radiciperda.*** The leguminous bush ***Tephrosia candida*** has been used similarly in India, but this is grown from seed, and the bushes retained in the land for 3 years. [*Cf.* Mann and Hutchinson, *Green Manuring in Tea, l.c.* 1906, No. 2.]

Fixation of Nitrogen.

Certain trees growing among tea are found to be beneficial. The best of these is ***Albizzia stipulata,*** but ***Dalbergia assamica*** has given similar results. These are planted from 40 to 60 feet apart throughout the garden. The lower branches are annually removed, so that the shade given may be as light as possible. [*Cf. Pests and Blights, etc.*, 136–47.]

Pruning.

Pruning.—The pruning of tea is an extremely technical process which can hardly be adequately described in a general notice such as the present. In nearly all the Indian districts it is an annual operation, and in North India is always carried out between December and March. In South India and Ceylon the time is not nearly so fixed, but if possible it should be always done during the non-growing period of the plant.

Best System.

Commencing with a tea seedling, one of the best systems of pruning on the plains of India is perhaps as follows:—After the tea seedlings have been on the ground 1 to 6 months (according to whether they have been planted out at a year old or at 6 months old respectively) they should be cut down in December or January. If of the "Assam" indigenous type this should be not lower than 6 inches from the ground; if of the "Manipur," 6 to 8 inches. Each plant ought then to throw out, from the stump, 3 or 4 stems, which are allowed to grow for 2 years before being pruned again. Then when they are 3 years old from seed, they are cut at 14 to 18 inches from the ground. After this, each year's pruning will be at a point from 1 to 2 inches above that of the previous year (light pruning), until the yield begins to diminish, when it will be necessary to cut back to 12 to 15 inches from the ground (heavy pruning). This ought not to be necessary till the bushes are more than 10 years old. At a later age, if the bushes are found to give a very low yield, it may be necessary to go even lower than this, and even in extreme cases to cut the bush down level with the ground (collar pruning), but this should not be necessary till after many years, if the garden be properly cultivated, manured and plucked.

In light pruning it is important:—

Conditions to be observed.

(*a*) To leave only a small length of new wood, say not more than 2 inches all over the bush.

(*b*) To cut the shoots at the sides of the bushes to the same length as those in the middle.

(*c*) To remove everything which is not likely to yield a new vigorous shoot in the following season. For example, remove all dead branches, all gnarled twigs and crow's-foot formations (clumps of imperfectly formed shoots), all trailing shoots on the outside of the bush, and all small useless twiggy shoots throughout the bush.

Effects of Pruning.

At high elevations growth is very much slower than in the plains, and heavy pruning will naturally be much less frequent than under ordinary conditions. And moreover there appears no doubt that growth made immediately after heavy or collar pruning gives a much lower grade of tea than can be obtained after light pruning. As the tea grown at the high elevations of hill districts usually depends for its commercial success on its high quality, heavy pruning is generally avoided as far as possible. [*Cf. Pests and Blights, etc.*, 78–100; Mann, *Exper. Heavy Pruning in Assam,* in *Ind. Tea Assoc.*, 1907, No. 3; also *Factors Deter. Quality of Tea, l.c.* 1907, No. 4, 17.]

Plucking.

Plucking.—The annual course of plucking, after light pruning, is about as follows:—When the tea has been pruned, new shoots begin to grow, and after 2 to 3 months have attained a length of 9 inches or more. At this stage the bushes can be "tipped," that is to say, the first lot of leaf may be taken off, the object not being so much to get the leaf as to force the production of secondary shoots on the plant. This "tipping" should be done when there are, on the shoots of the centre of the bush, *on the average* 6 leaves, without counting either the unopened tip-leaf nor the so-called "*janum*" leaf (really a bud scale) at the base of each shoot. Then the topmost two leaves may be plucked off, the plucking being done not by pulling, but by breaking (or nipping) the shoots with the thumb-nail. The level at which the average shoot, in the centre of the bush, is thus to be plucked is fixed, and it is a plan often followed to let the pluckers have a stick cut to the required height as a measure. Nothing is then plucked under this height at any part of the bush.

Method.

Measure.

This tipping forces a secondary growth from the axils of the leaves on the original shoots, and after about 3 weeks the secondary growth is ready to pluck, the uppermost 2 leaves and the unopened bud only being taken, and 2 mature leaves left on each of these secondary shoots. This plucking brings about the growth of a third series of shoots which rise from the axils of the leaves on the secondary growth, and on these one mature leaf is usually left behind when plucking the youngest "two leaves and a bud" as before. A fourth, fifth, sixth and seventh series of shoots arise in similar manner, and are known as "flushes." Eight distinct series of shoots is usually the largest number given by bushes in one season.

Flushing.

In the early part of the season the pluckings are almost coincident with the growth of the "flushes." After this they are much more frequent, and bushes are usually plucked from 20 to 30 times during the year, at intervals of from 7 to 9 days, during the greater part of the season. As has already been said, 4 mature leaves ought to be left on an average shoot in the first plucking, and nothing plucked below this level in the bush. The use of a levelling-stick is often continued for the first three or four pluckings of the season in order to prevent the premature plucking of the weaker shoots. Two leaves should be left behind in plucking the secondary growth, and one leaf in the next few pluckings at least, after which the shoots can be safely plucked as they grow. [*Cf.* Mann, *Factors Deter. Quality,* in *Ind. Tea Assoc.,* 1907, No. 4, 19 *et seq.*]

Premature Plucking.

Seasons.—It is essential to leave plenty of growth below the plucking-level in the earlier part of the season, and especially so after any heavy pruning. The growth and health of the bush are only secured by allowing abundant leaf to remain. Many fine tea estates have been seriously damaged by plucking off too much of the spring growth.

Seasons.

In Assam, and in fact North-East India in general, plucking commences about the end of March in each year. July, August, September and the first half of October are the months of greatest yield. After that time the crop gradually diminishes, and in Upper Assam plucking ceases for the season about the middle of December, while in Sylhet it may continue till the new year. The yield at each plucking during the height of the season from good yielding mature tea may go up to about 120 lb. of leaf per acre or even more, giving about 30 lb. of made tea. [*Cf.* *Pests and Blights, etc.,* 101–18.]

Yield.

Yield.—The object of the tea-grower is to get the maximum number of young shoots on the bushes in each year, as it is only the two, three, or at most four youngest leaves on any shoot which can be made into tea. A very small leaf crop can be obtained, under the system of pruning already set out, in the second year after planting; in the third year about 150 lb. per acre ought to be obtained, if in the plains. By the sixth year the tea (on the plains) is yielding a full crop, which varies, according to the soil, from 400 to nearly 1,000 lb. per acre per annum. Any crop above 700 to 800 lb. per acre is very abnormal, and due to special conditions. The average on the plains of India is rather under 500 lb. per acre.

Principle involved.

Deterioration of the Tea Plant.—This subject has been so fully dealt with in recent publications that it may suffice to give a reference to the literature. [*Cf.* Watt, *Pests and Blights* (1st. ed.), 155-60; Mann, *Treat. Deter. Tea in Ind., Tea Assoc.*, 1906, No. 4; also *Renov. Deter. Tea*, in *Agri. Journ. Ind.*, 1906, i., pt. ii., 85 96.]

Pests and Blights.

Enemies of the Tea Plant.—The tea bush is attacked by quite a legion of pests and blights, but owing to the fact that the tea crop is a continuous one for 8 or 9 months in the year, it is rare indeed that it is wholly destroyed. In the worst cases the yield is reduced possibly 20, 30 or even 40 per cent. In spite of this fact the damage done is in many cases extremely serious. For a complete treatment of the enemies of the tea plant the reader is referred to technical publications (more especially the *Pests and Blights, etc.*, 165–416). All that it is possible to attempt in this work is to furnish a list of the more serious pests and blights.

Insect.

Red Spider.—The pest which is almost always the first to appear in a garden is the "Red Spider" (*Tetranychus bioculatus, Wood-Mason*), a small red mite which sucks the leaves in the hot, dry weather of April, May and June, and afterwards, if dry weather continues. This leads to the checking of the growth and the weakness of the new shoots, and, hence, loss of crop as well as thinner and less vigorous wood as a basis for the next year's growth. The use of sulphur, applied by dusting on previously wetted bushes in February and March, is becoming very general as a means of counteracting this pest. [*Cf. Pests and Blights, etc.*, 348-59.]

Treatment.

Mosquito Blight.—The insect which causes by far the greatest damage to tea in India is, however, the so-called *Mosquito Blight* (*Helopeltis theivora, Waterhouse*). The losses due to this pest may be put down at 7 or 8 lakhs of rupees per annum. The insect itself is a capsid plant-bug, which passes the whole of its life-history on the tea bush, feeding on the leaves. It works by puncturing the youngest leaf and sucking the juice. The leaves thus quickly become a mass of brown, dry and withered material. It can be apparently combated and almost entirely eradicated from isolated gardens by spraying the bushes soon after pruning with kerosene emulsion and having a squad of children catching the insects throughout the year. Such a method is expensive, but has well repaid the cost on estates where mosquito blight has been serious. [*Cf. Pests and Blights, etc.*, 247-85; Mann, *Variations in Helopeltis theivora*, in *Mem. Dept. Agri. Ind.* (*Entom.*), i., No. 4.]

Treatment.

Green Fly.—The growth of the shoots on the tea bushes is often greatly retarded in the early part of the year, apparently by the activity of a jassid bug (*Chlorita flavescens, Fabr.*) known in the tea districts by the unfortunate name of the "*Green Fly.*" It seems to completely stunt the second, third and fourth flushes of the season chiefly, but has the compensating consideration that the tea made from shoots so stunted is invariably of higher quality than when they grow freely. No method of dealing with this pest has yet been devised. [*Cf. Pests and Blights, etc.*, 286–92; Mann, *Factors Deter. Quality Tea., Ind. Tea. Assoc*, 1907, No. 4, 16.]

Scale Insects.

Caterpillars.—The number of caterpillar pests of the tea plant is very great, those of the ***Psychidæ*** and ***Limacodidæ*** being perhaps the most numerous and most injurious. Little more than systematic catching has been attempted against these. Scale insects are of little or no importance in the plains, but become serious at higher elevations. The brown coffee-bug (***Lecanium hemisphericum***) has done serious damage in the Nilgiris, while in the north of India the most common species are ***Chionaspis theæ***, ***Eriochiton theæ***, and ***Carteria decorella.*** [*Cf.* Mann and Antram, *Red Slug*, in *Ind. Tea Assoc.*, 1906, No. 5.]

Vegetable.

Red Rust.—Among blights of vegetable origin perhaps the most serious and widely distributed is the so-called "Red Rust," caused by an alga (***Cephaleuros virescens***, *Kunz.*), which attacks tea of deficient vigour almost everywhere and kills nearly all the shoots on which it occurs. [*Cf.* Mann and Hutchinson, *Red Rust—a Serious Blight of the Tea Plant*, in *Ind. Tea. Assoc., Calc.*, 1904, No. 4.] Its treatment consists largely in increasing the vitality of the bushes by manuring, better drainage, and improved methods of pruning and plucking, but in serious cases BORDEAUX MIXTURE, applied to the bushes immediately after pruning, is also advised. [*Cf. Pests and Blights, etc.*, 396–408; Mann and Hutchinson, *Red Rust of Tea*, in *Mem. Dept. Agri. Ind.* (*Botany*), 1907, i., No. 6.]

Treatment.

Bordeaux Mixture.

Fungous Blights.—*Thread Blight*, caused by a fungus (***Stilbum nanum***, *Massee*) on the leaves and twigs of the bushes, has done considerable damage to individual plants, but can be got rid of by treatment with sulphide of lime (made by boiling lime and sulphur together in water). *Grey Blight* (***Pestalozzia guepini***, *Desmaz.*) is the most serious leaf-blight of the tea plant, and is very generally distributed. *Blister Blight* (***Exobasidium vexans***, *Massee*), another fungus which attacks the leaves and green shoots, is fortunately restricted to a small area at present in Upper Assam (Mann, *Ind. Tea Assoc.*, 1906, No. 3). *Tea Canker* (***Nectria*** *sp.*) destroys both young and old tea stems, more especially in damp situations. Lastly, *Root Rot* (***Rosellinia radiciperda***) causes the death of large numbers of bushes, more particularly round the dead stumps of certain trees.

Having dealt with CULTIVATION as fully as the available space will allow, it is now necessary to consider the methods presently adopted for the manufacture of the leaf into the commercial article Tea.

MANUFACTURE OF TEA.

Manufacture.

Introduction of Machinery.

The methods pursued have undergone a complete change in practice, if not in principle, by the introduction of machinery. Previous to 1860, and almost entirely previous to 1870, hand labour was exclusively employed to prepare the leaf for market; now (except for an occasional garden at the commencement of the season) the whole work is done by machinery, much of which is largely automatic. The machines used for the several processes in Black Tea preparation have been produced by three or four inventors, and the names of Kinmond, Jackson and Davidson almost entirely cover the field. It is not proposed to describe here the older methods of tea manufacture by hand, since these can be found in many of the books already referred to, but we shall limit attention to those at present in vogue. [*Cf.* Watt, *Journ. Roy. Hort. Soc.*, 1907, xxxii., 90–3.]

Grades of Tea.

Grades of Tea.—The tea-leaf when plucked may be manufactured into various classes of tea. Black Tea, at present, absorbs almost the whole of the leaf produced in India. The preparation of Green Tea has made, however, considerable progress in the past five years, largely owing to the invention of special machinery for its production and partly to the depressed prices obtainable for Black Tea. An effort has recently been put forth to introduce the manufacture of *Oolong* teas into India, but so far with no success. A small quantity of Brick Tea is made by a few estates in Darjeeling and Kumaon, for the Tibet and Bhutan market. "Letpet" or Pickled tea is prepared in Burma and on the hills lying between that country and Assam. These various grades of tea may be separately dealt with :—

Black.

1. ***Black Tea.*** ***Withering.***—The leaf, plucked as already described, is brought in from the estate, and immediately spread as thinly as possible in a cool and shady house on trays of hessian, bamboo, or wire netting to "wither." In the colder hill districts this operation is nearly always conducted in lofts, situated over the factory itself, which can be closed and warmed with hot air. In the plains similar lofts, fitted with fans to draw the air over the tea, are sometimes used, but the general consensus of opinion seems to be that when such lofts are used to shorten the withering by raising the temperature above 80° F., the quality of the tea invariably suffers. In the districts producing the best-grade tea (Upper Assam) the withering is almost entirely carried on in houses open to the outside air. Lofts in which hot air can be introduced are, however, very useful in ensuring that the withering is completed within a reasonable time, for the leaf must wither until it is flaccid, and if this takes too long, the tea is always inferior. At a temperature of 80° F. the ideal time required for withering is about 20 hours ; if delayed beyond that time a lower-grade tea is almost inevitable. If not flaccid at the end of the withering time it is a common custom to allow the leaf to remain for thirty hours, when it must then be taken away and rolled. The process of withering is a very important one in tea manufacture ; if well carried out, the amount of tea ferment (*enzyme*), which afterwards causes the change in the leaf termed "fermentation," nearly doubles in quantity during the operation ; the soluble matter in the leaf considerably increases as well as the tannin, to which the pungency of the finished leaf is due.

Quality affected by Withering.

Enzyme or Ferment.

Rolling.—When, by withering, flaccid leaf has been produced, it is ready to roll. This operation was formerly carried out by placing the withered leaf on a table, where it was rolled to and fro under the pressure of the hands, till the juice was pressed out on to the surface of the leaf, and the material well twisted. As the pressing out of the juice from the cells into contact with the air is the essential part of the process, it was soon apparent that a machine might be devised which would bring about this result and allow of a much larger amount of leaf being treated at once. Hence during the last forty years there has been invented a constant succession of machines. The earlier ones, by trying too closely to imitate hand rolling, were many of them cumbrous and unwieldy, but

Essential Feature.

gradual improvement has taken place, and those now in use leave little to be desired except the making of the process continuous. In principle, all the machines work by rubbing the leaf between two surfaces either rotating in opposite directions or working at right angles to one another. In some cases the pressure on the top of the leaf is supplied by the weight of a large quantity of the leaf itself; in others, and more commonly, by a special heavy lid to the machine. By raising or lowering this lid, the pressure on the rolling leaf may be altered, and the amount of juice expressed diminished or increased. Other things being equal, the lighter the rolling the more juice remains in the cells, and a pungent light-liquoring tea is obtained, in which the whitish colour of the immature tip-leaf is only slightly stained, thus giving a pretty-looking tea, full of "golden tip." If the rolling be hard, much juice is pressed out, the golden tips largely disappear, and a much darker liquor is afforded by the finished tea, but one with more "body" and less pungency. The time taken by this operation varies from a quarter of an hour to an hour or even more. Often the rolling is partly carried out, and the leaf is then sifted through rotating sieves. The finer portions (containing most of the golden tip) are not again put in the machine, while the coarser portions are subjected to rolling under a greater pressure.

Continuity Desired.

Pressure.

Golden Tip.

The juice has been brought into contact with the air by rolling; now occurs the so-called "fermentation." Before the rolling is completed the edges of the leaves and the ends of the stalks have begun to change from a green to a brown colour, and to take on an altered smell. This is the commencement of the fermentation, which is allowed to go on from two to six hours according to the conditions. For this purpose the rolled leaf is spread out about one to two inches thick in a moist, cool, darkened room, under conditions of the greatest cleanliness possible, and allowed to remain there. The material quickly becomes brown, and commences to smell like finished tea. The end of the operation is judged by the eye and the smell, and requires a good deal of experience to decide. The final product should be coppery brown in colour, like a new penny, and should have quite lost its leafy smell, taking on, as has already been said, that of finished tea. The changes which take place during the fermentation are still very obscure, and it will be better to leave their discussion till a little later (see p. 238).

Action of the Air.

Fermentation.

Brown Colour.

Firing.—Fermentation finished, the leaf must be dried or fired as quickly as possible. Formerly the firing was done over clear charcoal fires; now machines which make use of a current of hot air are exclusively employed. The earliest invented simply placed the leaf in trays through which a current of heated air passed, by natural draught, and as each tray was dried the material was removed and replaced. Now such machines are chiefly employed for finishing the tea-firing, and the greater part of the work is done on large automatic machines working with strong currents of air induced by fans. They are capable, some of them, of drying as much as two hundred pounds of finished tea per hour. The machines used for this purpose are simple in construction, and though ingenious, do not embody any new principle of drying. The "firing" is usually commenced at a high temperature, the air entering the machine being often kept at from 220° to 240° F., though naturally the drying leaf itself never reaches this temperature. After the drying is about three-quarters completed, a somewhat lower temperature is employed, from 180° to

Firing.

Temperature Employed.

Pungency Destroyed.

200° F. It is essential that the whole drying should be carried out as rapidly as possible, since if protracted, much of the pungency of the tea is lost.

Grading.

Broken Leaf.

Grading.—After drying, the tea is graded. The marks known on the market are—"Orange Pekoe," "Pekoe," "Souchong," "Congou," etc. These are old Chinese terms, but now used somewhat loosely on the supposition that certain leaves on the shoot form the bulk of the grade named. Thus the unopened tip (bud) and the first opened leaf are generally supposed to constitute the "Orange Pekoe," the next in descent is the "Pekoe" leaf, and still lower the "Souchong" leaf. The grades, however, are now merely commercial terms which have little relationship to any particular leaves. There is a corresponding class for the fine particles or so-called "Broken" leaf of each grade, which generally gives a stronger tea than the grade itself, and is hence higher in price. The principal market names in use at present are:—

1. Broken Orange Pekoe.
2. Orange Pekoe.
3. Broken Pekoe.
4. Pekoe.
5. Broken Pekoe Souchong.
6. Pekoe Souchong.
7. Broken Tea.
8. Souchong.

Tea-dust.

Tablets.

In addition there is a grade known as "Fannings," composed of the very small and light fragments of leaf not capable of being placed under any of these names, and "Dust," the extremely fine portions got out by sieving through a fine-mesh sieve, but even this has still a market value. In the *Kew Bulletin* (June 1890, 109–2) will be found particulars of the Hankow manufacture of the compressed tablets of the common tea-dust. These are said to be used throughout Russian Siberia.

Assortment.

These various grades are obtained from the tea just after being fired and by systematic sieving through sieves of various sizes, generally machine driven, coupled with the passage of the tea through "breakers" or "equalisers" in which the coarser leaf is broken down to a uniform length. After sorting in this way, each grade is packed separately in wooden boxes lined with sheet lead.

Tea Boxes.

"Venesta" and "Acme."

Lead Lining.

Packing and Tea Boxes.—Almost all the woods found in the tea districts have been used at one time or another for making tea boxes. Teak has even been imported from Burma for that purpose. For a long time *toon* or *poma* (*Cedrela Toona*) was the favourite, but as this became scarcer inferior woods have had to be employed. In the Brahmaputra valley practically the only timber now used locally for box-making is *semul* (*Bombax malabaricum*); in Sylhet and Cachar a greater variety is still employed, most being cut in the forests of the Lushai and Manipur hills and floated down the rivers to the saw-mills. There is, however, an increasing tendency to import boxes from other countries, even from China, Japan and Sweden—chiefly pine. Some patent boxes, made of Russian pine in three layers cemented together in opposite directions to the grain, have in recent years become popular under the name "Venesta," "Acme," "Columbia," etc. Their chief objection is their high price. Steel chests were introduced some years ago, but have been abandoned. It may be mentioned that the wood of which the chest is made is by no means a matter of indifference. Some timbers have the reputation of tainting the tea placed in them, giving it a so-called "cheesy" flavour, and quite a large number of timbers can only be used after long seasoning under water. Chests are always lined with thin sheet-lead, carefully soldered. It is of the utmost importance that the package should be as airtight as possible, since tea is exceedingly quick in absorbing moisture from the air (up to the amount of 16 to 17 per cent.) and then becomes rapidly mouldy and useless. Before packing, each grade of tea is always refired at a temperature of 180° to 200° F., and packed while still just warm. As put in the boxes, it commonly contains from 2 to 3 per cent. of moisture.

Airtight.

2. *Green Tea.*—For many years the manufacture of Green Tea in India may be said to have died out except in the Kangra Valley and in Kumaon. It was formerly made in some quantity, but black tea being the more marketable article, the green gradually ceased to be manufactured, especially after the introduction of machinery, since no apparatus had been devised for green-tea manufacture. While the object aimed at in preparing black tea is to change the materials in the leaf, by fermentation, the green colour becomes brown or black, the astringency is reduced, and the aroma altered in character: in manufacturing green tea, the aim is to prepare the leaf without any alteration taking place.

Green Tea.

Fermentation Prevented.—The first operation in manufacture is, always, therefore, to heat the leaf, immediately it is received from the pluckers and without any withering, so as to destroy the ferment (*enzyme*) and prevent any after-colouring of the leaf, and at the same time to bring the leaf into the soft condition required for rolling. When small quantities are dealt with, this result is obtained by panning. The pan is a large cast-iron basin 2 feet wide let into brickwork and with the hinder part about 1 foot higher than the front. This is heated from below. When the pan is "roasting hot" a small quantity of leaf is thrown into it and kept tossed about by hand so that no portion is allowed to rest on the hot iron long enough to get singed. When soft enough it is slightly rolled by hand, then panned again, and so panned and rolled alternately until the edges of the leaf become very slightly crisp. The leaf thus prepared is then dried off as quickly as possible, by methods and appliances similar to those described for black tea.

No Fermentation.

Panning.

Where large quantities of leaf have to be dealt with, machines have recently been invented by means of which the panning operation is replaced by a steaming of the leaf, under pressure, in a rotating cylinder. The steaming must be very short or the leaf gets a boiled-cabbage appearance and is then useless, and yet it must be treated long enough to ensure the destruction of the ferment. About 1½ to 2 minutes under a steam pressure of 20 lb. to the square inch is generally sufficient. After steaming, the excess of water is usually got rid of in a centrifugal machine, though much juice is lost at the same time. Then the leaf is rolled slightly in machines similar to those used for black tea. The rolling must only be slight, for broken grades are almost worthless in green tea. It is immediately thereafter dried off as rapidly as possible.

Steaming.

In order to obtain a green appearance in the final product it has been customary in China to "face" the tea by rubbing it, when finished, in a hot pan with a small quantity of indigo and gypsum or other similar mixture. In Kangra the Native manufacturers use a small quantity of greenish-coloured soapstone for this purpose. But the employment of such materials is to be deprecated, and a very fair finished surface can be given to the tea by rubbing it in a hot pan alone without any foreign material, which only too frequently assumes the condition of an adulterant.

Facing, Colouring and Weighting.

Grades of Green Tea.

Grades of Green Tea.—As already stated, in grading green tea "broken grades" are worth very little. The grades (as with black tea) are given Chinese names:—"Young Hyson" is the finest part of the tea, principally made from the youngest leaf on the shoots; "Hyson No. 1" corresponds with Pekoe among black teas; and "Hyson No. 2" is a coarser grade. "Twankay" is composed of the flat broken fragments of the coarser leaves; "Gunpowder," which has the appearance of balls about the size of small peas, is formed by the smaller leaves (which are very sticky after panning, and hence adhere together and so form themselves into small balls during rolling). The packing is similar to that for black tea.

Young Hyson.

Gunpowder.

A Cup of Green Tea!

Speaking of green tea, the following passage from Vigne (*Trav. Kashmir, Ladakh and Iskardo*, 1842, ii., 265) will be found interesting: "Tea, made or rather boiled with water, as in Europe, is called Moguli *chá*, or the tea of the Moguls, as they call the Persians. But Tibeti *chá*, or tea as made in Tibet, is a very different composition, for which the following is the recipe for a party of five or six people: a teacupful of the finest green tea is put into three pints of water, and upon this is strewed a large spoonful of soda, and all three are boiled together. About a pound of fresh butter or *ghi*, and a pinch of salt, are then placed at the bottom of the milling churn, and part of the boiling contents are poured out and milled like chocolate; a little cream or milk is then added to what has remained in the saucepan, and on this the milled tea is poured and boiled again, and part of it again transferred to the churn, and so on till it is all properly milled. All that then remains to be done is to strain it through a clean cloth. Much depends upon the quality of the tea, and the manner of making it. I have nowhere drank it so good as with Ahmed Shah. It was always made before or after a march, and on a cold morning I found it, after a little time, quite as palatable as tea made in the ordinary way, and far more nourishing. When well made, it resembles chocolate in appearance, in consequence of the reddish tinge imparted to the tea by the presence of the soda, which prevents it also from cloying. *Sutu*, or the flour of roasted barley, is frequently eaten with it."

Oolong Tea.

3. ***Oolong Tea.***—So far no *oolong* tea has been made in India; its manufacture is a speciality of Formosa, though also made in China and Japan. But Formosa *oolongs* have a recognised place on the tea market, principally on account of a very characteristic and much-desired flavour. Commissioners were sent from both India and Ceylon in 1904 to ascertain the methods by which this was produced. They reported that the flavour was principally due to the particular variety of plant grown. But that variety was not to be recommended on any other ground, as the yield was small, the plant was difficult to grow, and could only be satisfactorily propagated by layering. The manufacture was quite special in character, and in essentials was carried out as follows:—On the leaf being brought into the factory at midday, it is put out in the sun to be warmed, first spread thinly and then thicker, for twenty minutes to one hour. The leaf so treated is taken into a house and spread on bamboo trays in a layer about 3 to 4 inches thick. At intervals of 15 minutes it is collected together and shaken up with the hand. With this treatment continued for two hours a change occurs in the smell of the leaf, and a tinge of brown takes place on the softer leaf and on the edges of the others. When the discoloration has spread over the softer leaves in spots, the tea is ready

Special Variety.

Method of Manufacture.

Partial Fermentation.

Panning.

for panning. This operation is carried out by keeping the leaf constantly and evenly on the move in a pan about 2 feet in diameter, retained at a temperature of 360° to 400° F. and for about 10 minutes. Rolling follows, and finally firing in the small charcoal stoves used universally in tea manufacture in China and Japan. For further particulars the report of the Indian Commissioner, Mr. J. Hutchinson (*Cult. and Manuf. of Formosa Oolong Tea*, Calcutta, 1904) should be consulted.

Brick Tea.

4. ***Brick Tea.***—Hitherto little attempt has been made to manufacture Brick Tea in India, though it is the staple of the Central Asian trade. In view of the possibility that this trade may be opened up in the near future, a careful investigation was made in 1905 of the methods employed in Western China by a special commissioner sent by the Indian Tea Association to the districts in which it is produced. He describes in his report how it can be made either from the young shoots (as with black tea), which gives the highest quality of brick, or from coarse leaf with many stalks and twigs. In some cases, indeed, stalk and twig predominate in the material used.

Manufacture of.

The manufacture involves (1) *Panning*, in pans as described under green tea, kept at such a temperature that the leaf emits a sharp crackling sound, due to the bursting of the cells as it is rubbed over the surface. This operation takes from 6 to 10 minutes. (2) *Rolling*.—This process is carried out by hand in the usual manner, only light rolling, however, being done. (3) *Fermenting*.—Here the peculiar part of the manufacture comes in, for the leaf spread in heaps 3 to 4 inches deep is allowed to ferment for 3 to 4 days, the temperature rising in the meantime to 105° to 112° F. The resultant product is then dried in the sun. After preparation it has to be formed into bricks, and for this purpose it is first steamed over a boiler (5 lb. at a time) for 2 to 3 minutes, and will then have a temperature of 150° to 170° F. If few stalks are mixed with the leaf it will be found that a fairly firm brick may be turned out without any addition; if not, a mixture of boiled glutinous rice-flour is necessary to give sufficient adhesiveness. The whole is then put into a wooden mould of suitable size and shape and pounded down lightly with a wooden rammer weighing 17 lb. Several bricks are, usually, put in the same frame, separated by a layer of bamboo matting. The whole frame when filled is put aside for several days to set and dry; after which the bricks are taken out, trimmed, wrapped in paper, and put back into the case again. The bricks usually made are 10½ inches in length by 4 inches thick. [*Cf.* Horace Della Penna in Markham, *Journ. of T. Manning to Lhasa*, 1879, 119, 317.] The manufacture of brick tea differs in quality and material rather than in principle from the compressed tablets of tea-dust to which reference has already been made.

Panning. Rolling. Long Fermentation. Manufacture.

Letpet Tea.

5. ***Letpet or Leppett Tea and Lao Mieng Tea.***—The manufacture of this kind of tea is peculiar to Burma, the Shan States and some of the hills lying between Assam and Burma. A fairly complete account of the whole subject of its production will be found in the *Kew Bulletin* (1896, 10) and in *The Agricultural Ledger* (1896, No. 27, 235–66). There seem to be two ways of preparing it, as follows:—The leaves are first thrown into boiling water and allowed to remain for a short time or until they become soft, then are taken out and rolled by hand on mats and allowed to cool. The process which follows consists in ramming the leaves down tight into the internode of a bamboo (the

"*Wabo*"), a wooden ramrod being used for the purpose. A stopper is then made of jack or guava leaves, and the bamboos thus charged are then kept in the shade for a couple of days with the stoppered ends downwards to allow of any water there may be within to drain off. The bamboos are not filled up quite to the top with *letpet,* and in the space thus left ashes mixed with a little water are now filled in. The object of the ashes is to prevent insects getting to the tea. The bamboos are now buried underground till the *letpet* has matured and is required for sale. If not buried the *letpet* becomes black and spoilt; to be good it should be of a yellowish colour. It is carried to market for sale in bamboo baskets of open wicker-work (*kyin*) lined with leaves. The tea is taken out of the bamboos, filled into the baskets, and pressed down tight so as to prevent air injuring it.

The above is the method in vogue west of the Irrawaddy. East of that river the method seems to consist in steaming the leaf and then rolling by hand. After this the leaves are allowed to cool and are then deposited in a pit, lined with planks or bamboo matting, and covered over and pressed down by heavy weights. The pit is not opened till a purchaser turns up to buy the whole pitful, but when opened the *letpet* tea is removed in bamboo crates.

Usage at Ceremonials.

[It may be useful to amplify Dr. Mann's account of this tea (above) by a few quotations and observations:—The earliest mention of it (apparently) is in Hamilton's *New Account of the East Indies* (1688–1722, pub. 1727, ii., 62), where he says, "They never leave mediating till there be a reconciliation, and, in Token of Friendship, according to an ancient Custom there, they eat *Champock* from one another's Hand, and this seals the Friendship. This *Champock* is Tea of a very unsavoury Taste; it grows, as other Tea does, on Bushes, and is in use on such occasions all over Pegu." Crawfurd, Ferrars, Nisbet, etc., all speak of its use at ceremonials.

Lao Tea.

The account given by Mr. C. E. W. Stringer (*Kew Bull.*, 1892, 221) of the manufacture of Mieng or Lao Tea in Bangkok does not differ in any material sense from the practice in Burma. These may therefore be described as Siloed teas, and their chief peculiarity may be said to be that they are eaten as a pickled vegetable and only rarely used as a beverage. Crawfurd says the leaves are elliptic, oblong, and serrated like the Chinese plant; and the Burmese, not following the practice of other nations, designate the latter by the native name of their own plant, *Lap'het.* There is little doubt, therefore, but that it is a genuine *Thea*, and most probably a native of the country. Crawfurd speaks of Wallich as his friend, and yet at the very time indicated the latter disbelieved in tea being indigenous in Assam. Crawfurd (*Journ. to Ava,* 1834, i., 199, 236; ii., 147, 214) says,

Burmese eat Tea.

"The Burmese eat the leaf prepared with oil and garlic, and never use the infusion as they do that of Chinese tea, which they call *Lap'het-re*, or tea water." Ferrars (*Burma*, 1900, 65, 70, 72) speaks of pickled tea as made by the hill tribes to the north. Nisbet (*Burma Under Brit. Rule and Before*, i., 175, 446; ii., 191) observes, "In Upper Burma and the Shan States a good deal of this tea is consumed as a drink, for which purpose it is sold in a dry state. It is prepared by boiling it in an earthen kettle, and is drunk with salt. The greater bulk, however, is sold by the Mandalay brokers to merchants in Lower Burma, where it is largely consumed in the solid. The leaves are soaked in oil, a little garlic and dried fish, etc., added, and the concoction thus formed is eaten and considered a great luxury. Besides being regarded as a dainty, however, the '*Leppett*', is a traditional food among Burmans. At the important junctures of a man's life, such as birth, initiation into the church, marriage and death, '*Leppett*' plays an important part, and no ceremony is complete without the consumption of that article. The tea remains in the same basket from the time it is bought at the gardens until it is sold by the merchant to the actual consumer. Large numbers of baskets are to be seen at every wharf along the Irrawaddy banks and in the bazaars throughout the country."

Plant of Early Times.

It would seem probable, however, that in Burma the word *lapet* denotes *Camellia drupifera*, and that that species may possibly have been employed in the manufacture of *letpet* tea before the adoption of *C. Thea* as the preferable plant. Further, there appears little doubt that tea was first used as a medicine, then as a vegetable, and finally as a beverage. It was the discovery of this final property that gave the greatest impetus to the cultivation of *C. Thea* in China and Japan, and possibly also in Burma long anterior to any records of the introduction and cultivation of the plant in India. Symes (*Emb. to Ava,* 1795, ii., 255) mentions *læpac* or pickled tea, and Mason (*Burma and Its People,* 1860, 505) has a similar reference.]

6. ***Jyree Tea.***—Some few years ago a tea was much talked of in the public press as having special merits. This was found to consist of ordinary tea mixed with a certain percentage of the leaves of *Albizzia amara* (see p. 45).

Chemistry of Tea.

CHEMISTRY OF TEA.—Within the scope of this work it is neither possible nor desirable to give a detailed account of all the substances which have up to the present time been found to occur in the tea-leaf. The soluble materials combine to make the liquor produced by infusing the manufactured tea. But it may be observed that both the commercial and the hygienic value of tea as a beverage depend on three or four substances. The *first* of these is the so-called ESSENTIAL OIL, the supposed cause of the flavour. It is impossible to deal with this substance here; briefly its character is all but unknown, its quantity remarkably small even in the most flavoury teas, for though Mulder (*Poggend, Annalen,* xliii., 133) obtained 0·6 to 1 per cent., no one since his time has been able to isolate anything like that amount. In fact it has been denied that he was dealing with the oil which was subsequently extracted by Van Romburgh (1895) by the distillation of freshly fermented leaves, the yield being only 0·006 per cent. It is a product of fermentation. The essential oil has, generally speaking, almost entirely eluded investigation. Its connection with flavour is well known, but the oil itself remains almost unexamined. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils,* 1900, 501-2.]

Essential Oil and Flavour.

Caffeine or Theine.

The *second* of the important constituents of tea is the CAFFEINE OR THEINE, to which almost the whole of the stimulating power of the tea seems to be due. From a medical point of view it is the most important substance: from a commercial standpoint it appears to have little value. The higher-priced grades of tea certainly contain more caffeine than the lower, but this is simply because the younger leaves (which have a higher percentage) form the bulk of the finer grades. Given two Broken Orange Pekoes, however, the relative quantities of caffeine they contain will bear little or no relation to their prices.

The total quantity of caffeine present in tea varies from 3 to 5 per cent., and this quantity undergoes no change during the processes of manufacture. On the other hand, the ease with which it is extracted is by no means so great in the fresh leaf as in the finished black tea. Nanninga (*Mededeelingen uit 'slands Plantentuin*, 1901, xlvi., 3) gives figures, for instance, where the quantity extracted by the same method increased from 2·51 to 3·77 per cent. in passing from fresh leaf to fermented and finished black tea.

Tea Refuse.

In this connection it might be pointed out that tea refuse is practically the only commercial source of caffeine. From this it is, however, produced at the rate of 30,000 lb. yearly, or thereabouts, the manufacture being carried on in England, Germany, France, and America. Recently successful attempts have been made to extract the caffeine on a commercial scale, from the tea on the spot in India, and it is probable that this manufacture, as an attachment to tea estates, may take a considerable development in the tea districts of the country.

Tannin.

The *third* constituent of great importance in the tea-leaf and also in the tea is the tannin. A great deal has been written of the evil effect of the tannin in tea, most of which is, however, not based on exact experiment, but rather on general impressions. Whatever be its physiological action it is certain that it is the constituent which gives tea its pungency, and, in its form oxidised during fermentation, it also imparts the colour to infusions of tea. In short, from a commercial point of view the value of Indian tea, in so far as it is determined by pungency and colour of liquor, varies with the quantity of tannin easily extractable by water.

Estimation.

The quantity of tannin is, however, very variable, and during manufacture alters to a very great extent. If we take the quantity extracted by water in ten minutes at 212° F. from finely divided tea as the standard, the following represents the reduction which normally takes place (as determined by hide powder) during the manufacture. All the figures are calculated on the dried material.

	(1)	(2)	(3)
Tannin in leaf as rolled	15·51	16·90	16·98
Tannin in finished black tea	12·94	12·53	13·78

The colour of the liquor given by fermented tea is due to the oxidised tannin produced during the fermentation process, and in practice it always becomes a question of skilful management to know how far "to sacrifice pungency to colour"; in other words, how much of the tannin is to be allowed to oxidise during manufacture.

Tannin Oxidised

Expressed Juice.

Enzyme

In a normal fermentation conducted below about 82° F., the oxidation, produced by the *enzyme* already mentioned, is a perfectly definite and complete operation. All the tannin pressed out of the cells and brought in contact with the air is oxidised in from four to six hours according to the temperature. The relative colour and pungency of the final product depend, if a complete fermentation is allowed, on the amount of rolling and hence of juice expressed. If the process is conducted much above 82° F., other oxidations take place, independent of enzyme action, and these give the tea a "stewed" taste, while rapidly lowering the tannin percentage without increasing the colour of the infusion. The explanation is probably that the fermentation of the tannin by means of the tea oxidase (enzyme) only carries the oxidation one stage forward, and though the products are not as soluble as the original tannin, they are still fairly soluble, and have a brown colour. At higher temperatures still more deeply brown oxidation products are formed, much less soluble in water. The result is disastrous to the tea, and hence no fermentation should be conducted at a temperature above 80° to 82° F., if this is possible. [*Cf.* Mann, *Ferment. of Tea*, in *Ind. Tea Assoc.*, 1906. No. 19, pt. i.; 1907, No. 1, pt. ii.]

The tannin present in the original leaf has been carefully examined and described by Nanninga (*l.c.* 7). He found it to be a crystalline powder, so hydroscopic that an instant's exposure to the air turned it into a yellowish-brown syrupy mass. It is not soluble in chloroform, benzine or petroleum ether, and very little in anhydrous ether. On the other hand it is very soluble in alcohol, acetone, or acetic ether. It has a very astringent, but not bitter taste. It is precipitated by copper sulphate and lead acetate. Ferric chloride gives a deep blue precipitate. It is optically active.

Gallic Acid.

The other substances present in tea-leaf are of minor importance. A trace of gallic acid can always be found, as well as quercitrin. An acid, to which the name of *Boheic Acid* was given, has been described by Rochleder (*Ann. Chem. Pharm.*, 63, 202), but its existence as a definite chemical substance is very doubtful. Other constituents it seems unnecessary to describe. [Harold H. Mann.]

Trade in Tea.

TRADE IN INDIAN TEA.—The prosperity of the Indian Tea Trade may be mentioned as one of the many striking results of the British Administration in India. The East India Company enjoyed for many years a monopoly in the Chinese exports of tea, and they were therefore, and perhaps naturally, not over-anxious at first to establish a tea industry in India. In the year 1721 the imports of tea from China into Great Britain became one million pounds, and during the century from 1710 to 1810 the aggregate sales of the Company were 751 million pounds, valued at close on 130 million pounds sterling. It may be useful to recapitulate some of the historic facts already mentioned. In 1788 Sir Joseph Banks suggested the desirability of cultivating tea in India. Little was accomplished, however, until Lord William Bentinck became Viceroy in 1834. But the success shortly after attained was such that in 1840 the Government were able to withdraw from tea-planting, and by 1865 had handed over all their experimental plantations to private enterprise. The first public sales of Indian-grown tea took place in Calcutta during 1841, when 4,613 lb. were sold. A sample of Indian-made tea had, however, been sent to England a few years earlier (1838). By way of contrast with these beginnings it may be added that sales of Indian tea in 1904 stood at 200 million pounds, valued at £6,000,000 (see p. 218).

1721.

1788.

Originated 1834.

Government withdrew.

First Sales 1841.

Present Position.

Area.

Area and Localities of Production—Capital and Labour, etc.—The area under tea at the end of 1903 extended over 524,827 acres, nearly two-thirds (64·4 per cent.) being in Assam (viz. 338,278 acres, or 204,702 in Assam proper, and 133,576 in Cachar and Sylhet). In Bengal the area was 135,956 acres (25·9 per cent.). Thus these two provinces (Assam and Bengal) have nine-tenths of the Indian tea area, the remaining tenth being in the United Provinces, Panjáb, Madras and Travancore, a total of 49,073 acres, of which one-half is in the Native State of Travancore. In addition to all these there is a small area of 1,520

Recent Returns. Reduction in Area.

acres in Burma. In the latest report of the Commercial Intelligence Department on the Production of Tea in India, the area for 1906 is stated to be 531,808 acres, distributed thus:—*423,828 in Eastern Bengal and Assam; 51,219 in Bengal;* 7,997 in the United Provinces; 9,425 in the *Panjáb, and 39,339 in South India (Madras and Travancore).* Hence the *partition of Bengal may be spoken of as having reduced the area in that* province and increased that of the new provinces of Eastern Bengal and Assam. It may also be said that the record years in the normal or continuous expansion of the tea area were 1897 and 1898, but recently the low prices that have prevailed have suggested the desirability of curtailing rather than increasing the area, and accordingly in 1903 a decrease of 430 acres was recorded. The policy presently pursued may be described as the abandonment either permanently or temporarily of a percentage of indifferent tea, also the reduction of the quantity taken annually from the plant. Both factors have combined to improve the stock and raise the quality of the tea, and have thus proved beneficial. The reduction of area mentioned is therefore the balance between fallowed tea and new extensions, showing a small net decrease.

Yield. Distribution.

Yield.—But a significant feature of Indian tea-planting is the fact that production has increased in a higher ratio than the expansion of the area of cultivation. Since 1885 the area has increased by 85 per cent. and the production by 192 per cent. This doubtless denotes improvement in cultivation and manufacture. But the published estimates of production are usually considerably below the actuals, hence the trade returns show higher totals than the estimates of supply. Obviously there are many explanations, such as the fluctuations in seasons which render averages fallacious and the returns of private concerns not being as a rule furnished. On the average of the last five years the yield per acre (dividing total yield by area) was in the four chief tea localities: Brahmaputra valley, 401 lb.; Surma valley, 503 lb.; Duras, 476 lb.; and Darjeeling, 267 lb. to the acre. But according to the report of the Commercial Intelligence Department for 1906, the total production in this year was 240,411,266 lb., assorted thus:—Assam, 162,468,034; Eastern Bengal, 44,602,885; Bengal, 15,531,692; Northern India (United Provinces and Panjáb), 3,527,863; and Southern India (Madras and Travancore), 14,280,792 lb.

Capital. Per Acre.

Capital.—The total registered capital invested in the industry comes to 22 crores of rupees (£14⅔ millions), thus:—companies registered in India, Rs. 3,41,82,985, and companies registered in London, Rs. 18,39,30,135. Divided by the area this capital comes to Rs. 412 (£27) per acre. But there is a further unknown figure representing the capital of private owners (above alluded to), who, as a rule, refuse to furnish any information of their business, so that the total capital has been estimated at £20,000,000 (see p. 218).

Labour. To Acre.

Persons Employed.—In 1906 the number of persons employed in the industry was returned at 491,457 permanently and 81,642 temporarily, or just a little more than half a million, and this expressed to the area of cultivation comes to about 1·08 persons to the acre. These figures do not, of course, include those engaged in the carrying agencies nor those concerned in cultivating locally the food, etc., of the special immigrant tea population.

Foreign.

Foreign Trade.—The economies due to the establishment of large plantations, and the discovery of machinery to do all and more than

Chinese Trade.

Ceylon Started.

Race between India and Ceylon.

Most Recent Returns.

manual labour could accomplish, cheapened production, and with this arose a rapidly increasing demand. The freedom from adulteration and impurity, incidental to all Asiatic hand labour, also tended to enhance the appreciation of the Indian tea in European markets, and with that success came the downfall of the Chinese trade. In 1859 China supplied England with 76 million pounds of tea, and in 1880–1 with 175 million pounds. In 1864 India commenced to export in sufficient quantity to justify the traffic being recorded separately. In that year the United Kingdom obtained 2,800,000 lb. of tea from India. A decade later the coffee industry of Ceylon began to show signs of the ruin that finally overtook it. Profiting by the experience and knowledge gained in India, Ceylon planters abandoned coffee and took to tea, and to-day Ceylon is India's chief competitor in the tea markets of the world. In 1875–6 the exports from Ceylon were 784 lb. valued at £180, while the Indian of that year were 24,361,599 lb. valued at £1,444,278. In 1885–6 the Ceylon exports became 7,851,562 lb. valued at £382,996, and the Indian 69,666,000 lb. valued at £3,298,000. In 1895–6 the Ceylon exports were 110,095,000 lb. valued at £3,075,000, and the Indian 142,080,000 lb. valued at £4,682,000. Five years later (1900) the corresponding figures were: Ceylon exports, 149,265,000 lb. valued at £3,582,000, and Indian, 176,387,000 lb. valued at £6,118,000. By way of comparison it may be added that the total exports from China in 1900 were 184,533,000 lb. valued at £3,949,000, and Japan, 61,028,000 lb. valued at £1,406,000; the world's increasing demands were thus met by India and Ceylon mainly. This may be still further exemplified by later figures drawn from the report issued by the Commercial Intelligence Department of the Government of India for 1906. The total exports by sea and land routes for that year came to 236,731,623 lb. from India and 170,527,146 lb. from Ceylon, while from China came 108,864,534 lb. black and green tea, with 79,506,133 lb. brick, tablet and dust.

Prices.

India Leads.

Consumption to Population.

Great Britain and her Colonies.

Green Tea.

Prices Realised.—During the later years of the period indicated by these returns the price paid for Indian tea fell from 13·33*d.* to 8·32*d.* per lb. in 1900; for Ceylon from 11·63*d.* to 5·40*d.* per lb.; for China from 7·26*d.* to 5·14*d.* per lb.; and for Japan from 7·17*d.* to 5·53*d.* per lb. Thus, while India has maintained her position as the leading producing country, she has also preserved, in a remarkable degree, her supremacy in quality and price. Indian teas fetch the highest average price in the world. Expressed to head of population (census of 1900), the consumption of tea is interesting, and throws a flood of light on the influences that have led to the world's increased consumption of tea. The list is headed by Western Australia, 10·07 lb. per head of population; South Australia, 8·87 lb.; United Kingdom, 8·44 lb.; New South Wales, 8·01 lb.; Victoria, 7·38 lb.; Queensland, 7·09 lb.; New Zealand, 6·78 lb.; Tasmania, 6·62 lb.; Canada, 4·29 lb.; Holland, 1·48 lb.; United States, 1·14 lb.; Russian Empire, 0·93 lb.; German Empire, 0·13 lb.; and France, 0·05 lb. Thus India and Ceylon owe their prosperous tea trades, primarily, to the demands of Great Britain and her Colonies, but the low prices that have recently prevailed have led to great efforts being made to open out new markets, and these are held to have been so successful that the average price has improved. The relief afforded, moreover, by the endeavour to produce and sell green tea may also be said to have considerably strengthened the position of the Indian planter, so that it is thought there is now no longer any fear of supply outrunning demand.

Trade

Exports.

Exports from India (Black and Green Teas).—It may now be useful to furnish more direct and explicit information regarding the recent Indian traffic in Tea. The following figures show the trade every fifth year since 1876–7:—

Year.	Rs.	lb.
1876-7	2,60,74,251	27,784,124
1880-1	3,05,42,400	46,413,510
1886-7	4,72,79,917	78,702,857
1890-1	5,21,92,335	107,014,993
1896-7	8,12,45,480	148,908,461
1900-1	9,55,09,301	190,305,490
1906-7	9,85,77,642	233,653,637

Analysis of Exports.

An analysis of the traffic for the years 1902–7 may be framed to show the chief provinces of India from which exported and the more important countries to which exported, the figures given denoting the respective shares taken, while the unaccounted for balances, on the total transactions, manifest all other provinces or countries not mentioned. *The last three figures have been purposely omitted from each return* :—

EXPORTS.		1902-3.	1903-4.	1904-5.	1905-6.	1906-7.
Grand Total ..	lb.	181,423	207,159	211,887	214,223	233,653
	Rs.	7,36,16	8,55,79	8,46,54	8,84,76	9,85,77
Share *from* Bengal	lb.	170,943	195,107	197,541	199,737	175,889
	Rs.	6,76,52	7,88,17	7,65,39	8,00,91	7,36,96
,, ,, Madras	lb.	6,482	8,744	11,069	12,679	13,979
	Rs.	40,01	51,74	65,20	75,28	82,80
Share *to* U.K ..	lb.	152,895	170,186	167,691	166,591	176,169
	Rs.	6,27,90	7,08,91	6,70,97	6,89,01	7,57,45
,, ,, Canada ..	lb.	5,554	8,575	12,607	15,018	14,514
	Rs.	22,00	35,49	54,79	67,10	66,01
,, ,, Australia	lb.	4,568	6,402	5,892	7,146	8,962
	Rs.	16,36	23,47	22,15	26,53	31,37
,, ,, China ..	lb.	379	5,701	611	1,709	3,418
	Rs.	93	20,51	1,37	5,42	8,31
,, ,, Russia ..	lb.	3,967	4,546	9,331	9,988	13,761
	Rs.	15,08	17,49	32,99	42,62	56,50

Imports.

Imports into India (Black and Green Teas).—With such a record of producing enterprise it is somewhat surprising that India nevertheless should continue to import tea from China, Java, etc., and become the emporium of a re-export trade in these teas to Persia, Arabia, Turkey-in-Asia, Africa, Egypt, etc. The following table records the transactions during the past five years :—

Analysis of the Imports.

IMPORTS.		1902-3.	1903-4.	1904-5.	1905-6.	1906-7.
Grand Total	lb.	3,848	3,672	3,734	3,799	2,683
	Rs.	20,59	20,83	18,96	18,34	14,14
Share *from* China ..	lb	2,111	2,141	1,229	1,306	1,028
	Rs.	12,71	13,63	8,83	8,29	8,49
,, ,, Java ..	lb.	267	305	199	151	322
	Rs.	2,14	2,15	1,28	1,15	2,29
,, ,, Straits Settlements	lb.	491	542	532	491	457
	Rs.	1,75	1,89	1,95	1,82	1,85
Share *to* Bombay ..	lb.	3,055	2,838	2,822	2,935	1,990
	Rs.	17,29	17,30	15,25	14,75	13,26
,, ,, Burma ..	lb.	503	558	558	518	486
	Rs.	1,82	1,96	2,07	1,95	1,98
RE-EXPORTS TOTALS	lb.	1,606	889	926	781	501
	Rs.	10,49	6,46	6,32	5,20	3,08

Drawn from these foreign supplies the exports (re-exports) shown above are made, and it is distinctly interesting to have to add that recent special endeavours (already alluded to) have been directed toward securing for Indian production a larger share in the Tibetan and Central Asiatic green-tea traffic. But, more interesting still, the re-exports of China tea to Persia have as rapidly declined as the exports of Indian tea have increased. The growth of a trade with Persia and Turkey-in-Asia in Indian-grown teas is one of the most satisfactory results of the efforts to find markets outside the British Empire.

Green Tea Traffic.

Coastwise Trade.

Local Consumption.

Coasting Trade.—A study of the amount of tea carried coastwise to and from the provinces of India helps greatly to elucidate the particulars available regarding local consumption. In 1903–4 the total quantity carried by these routes came to 4,806,674 lb. valued at Rs. 23,94,580, and in 1905–6 to 4,179,040 lb. valued at Rs. 20,81,036. Of that amount, Bombay alone in 1903–4 took 3,089,500 lb., of which 3,000,000 lb. were drawn from Calcutta and thus doubtless consisted of Assam or Bengal teas, and in 1905–6, 2,093,516 lb., of which 2,000,000 lb. came from Calcutta. To a large extent perhaps this represents the Persian Gulf traffic. The only other item of importance manifested by the coastwise trade is concerned with the port of Chittagong.

Sources of Supply.

Rail and River-borne Trade.—The study of the official publications that have appeared under this heading reveals two important features: (*a*) the sources of supply upon which the great centres of the trade depend ; (*b*) the expanding local consumption. The total exports from the producing centres were in 1903–4 as follows :—From Assam, 150,841,296 lb. ; from Bengal, 46,936,472 lb. ; from Madras, 5,084,328 lb. ; from the United Provinces, 1,911,912 lb. ; and from the Panjáb, 655,918 lb. These show a total of 205,429,926 lb. as the exported production of 1903–4 ; but later statistics for 1906–7 show a slight increase to 224,873,712 lb. It is just possible that there is in addition, however, a small export traffic by road, not recorded in the above figures, more especially from small private gardens that run for special, often local markets.

Calcutta. Bombay. Madras. Karachi.

Calcutta imported in 1903–4 (from all those areas of production) a total of 170,735,726 lb. ; Bombay (town) secured 2,205,308 lb. (from the United Provinces and Panjáb, in addition to its supplies coastwise above mentioned) ; the Madras (port) towns received 4,912,292 lb. (drawn from the Nilgiri hills, Wynaad, Travancore, etc.) ; and Karachi 29,356 lb. (from the Panjáb and United Provinces). From these receipts, by the port towns mentioned, have to be drawn the foreign exports (already shown), the balance being one item more of local consumption. So in the same way the supply procured from the chief towns concerned in the foreign trade (177,899,082 lb.) deducted from the total recorded exports from the areas of production would leave a balance which either goes into local (provincial) consumption, or is exported from other port towns not dealt with above, such as Chittagong. The balance in question (in 1903–4) came to 27,530,844 lb. Now that Chittagong has become the seaport town of the new province of Eastern Bengal and Assam, its trade will doubtless be separately returned. In the Administration Report of Bengal (1903–4, 82), it is observed that the running of a direct line of steamers from that port to the United Kingdom and the through connection with Assam, established by the completion of the Assam-Bengal Railway, have already caused a large increase in the foreign trade, the total value of which was Rs. 2,50,66,000 in 1903–4 as against Rs. 1,69,71,000 in 1902–3. Of these returns tea represented a traffic of Rs. 75,60,000 in 1902–3, which expanded to Rs. 1,02,40,000 in 1903–4. It is thus certain that Chittagong will in the near future play an important rôle in the tea trade. But to conclude these observations on internal trade and local consumption, a balance sheet might be given by showing production less foreign exports and foreign imports less re-exports, and these two sums would doubtless represent very largely local demands; but for the reasons indicated it often happens that the exports exceed the estimated production by as much as a million pounds, so that we are not in a position to give any very satisfactory conception of India's own consumption of tea. Recently, however, a special company has been organised to pioneer the Indian home trade, and it is believed the results are fulfilling all expectations.

Chittagong.

Local Consumption.

Trans-frontier Trade.

Trans-frontier Land Trade.—The trade in tea across the frontier of India by land routes is not very important, though worthy of consideration. The most surprising feature is that (including Burma) India IMPORTS if anything more than she EXPORTS. The supply comes mainly from the Northern Shan States, is carried into Burma, and is mostly pickled tea. The total traffic was in 1903-4, 2,020,256 lb., valued at Rs. 9,31,943; in 1904–5, 2,314,816 lb., valued at Rs. 10,78,031; and in 1906–7, 2,120,048 lb., valued at Rs. 8,89,068. Turning now to the EXPORTS: these go mainly to Afghanistan, Kashmir, Dir, Swat and Bajaur. The following were the amounts exported—in 1903–4, 2,439,248 lb., valued at Rs. 10,68,916; in 1904–5, 2,731,008 lb., valued at Rs. 12,40,253; and in 1906–7, 2,991,072 lb., valued at Rs. 14,53,888. The chief item in this traffic is India's contribution to the Tibet and Central Asiatic demand for green tea.

In conclusion, it is perhaps scarcely necessary to enter into the details of the strenuous efforts that have been made and are being made by the Tea Association and tea merchants of India and England to extend the area of demand for all grades of Indian tea. The enlightened action which has resulted in securing the services of expert scientific officers to investigate the disabilities of the industry and to improve the methods of production and manufacture deserve the highest commendation. The initial stage in this reform was accomplished by the Government of India in 1895, namely the deputation of the Reporter on Economic Products to the tea districts with instructions to institute inquiries into and to publish a report on the "Pests and Blights of the Tea Plant." In consequence the first scientific officer—Dr. Harold H. Mann—was appointed by the Association. The subsequent history is one of progress. Mann's investigations cover every possible aspect of inquiry, and the results of his labours may be described as both highly interesting scientifically and of the greatest practical importance to the industry.

D.E.P., ii., 84 93. Camphor.

CAMPHOR: *Pharmacog. Ind.*, iii., 200.

The vernacular names in India, like the majority of the European names, are very similar, viz. Camphor (Engl.), *camphre* (Fr.), *kamfer* (Germ.), *canfora* (Ital.), *kárpúra* (Sansk.), *káfúr* (Arab.), and *kápúr* (Hind.), etc., etc. It has been suggested that they may have been derived from the Javanese *kápúr*, which seems to denote both lime and camphor. The Sanskrit medical writers were familiar with the two qualities *pakva* and *apakva*. The former would mean prepared by the aid of heat, and might thus be viewed as the Camphor of ***Cinnamomum Camphora***, while the latter would be native or natural camphor, and be accepted as denoting the camphor of ***Dryobalanops Camphora***. The last-mentioned was historically first known. But neither of the plants named are indigenous to India, nor even cultivated plentifully to-day, and therefore the *pakva* and *apakva kárpúra* could only have been known to the people of India subsequent to the establishment of the Chinese and Arab commerce. But the history of the names for the clove (and there are many other examples) show that it is not necessarily the case that commercial names, at present in use, originated from the indigenous names of the plants in question, so that the Sanskrit *kárpúra* might easily enough have given the Javan *kápúr*.

Two Forms.

Indian Camphor-wood.

History.—The *bhimsini* Camphor trees of the *Ain-i-Akbari* (Blochmann, transl., 78–9) were doubtless ***Cinnamomum zeylanicum***, the wood of which might have been called camphor-wood from its smelling something like camphor, and might easily have been viewed by Abul Fazl as an Indian discovery of the plant that yielded camphor. One of the earliest notices of camphor is that of the Arab merchant Sindbad (who lives to us in *The Thousand and One Nights* as a hero of fiction rather than of actual adventure and exploration), whom Baron Walckener thought had lived about the time of Solaiman, a Muhammadan merchant of the beginning of the ninth century. Sindbad describes the mode of extracting the camphor by making incisions in the trees that produce it. This was during his second voyage when he visited the peninsula of Riha, doubtless the Malay Peninsula. Adams (Comment., *Paulus Ægineta*, iii., 427–9) reviews the early information regarding camphor, and says that Serapion is the first authority who gives a full account of it. Isaac Ebn Amram, one of the writers quoted by Serapion, furnishes a brief account of the method of refining, which is practically that pursued at the present time. Lastly, Adams adds that Symeon Seth is the only one of the Greek authors who treats of camphor (*caphura*). [For further information see **Cinnamomum zeylanicum**, pp. 313–6.] Garcia de Orta discussed in the 16th century the two chief forms of Camphor. These are:—

Japanese and Formosan.

Cinnamomum Camphora, *Nees and Eberm.*; *Fl. Br. Ind.*, v., 134; Grasmann, *Mittheil. der Deutsch. Gesellsch., etc.*, Tokio, 1895, vi., 277–328; *Ind. For.*, xix., 459; xxiii., 469; Gamble, *Man. Ind. Timbs.*, 564; Brandis, *Ind. Trees*, 534; LAURACEÆ. The Japan Camphor Tree. A moderate-sized evergreen tree, native of China, Japan, Cochin-China and Formosa, much planted in India, where it grows admirably in suitable places. There are fine trees in the Botanic Gardens of Calcutta and Saharanpur; it grows very well in Dehra Dun, and thrives in the Nilgiris, even up to altitudes of 7,000 feet.

Production.

This is by far the most important of the natural sources of camphor, and practically constitutes a monopoly of the Japanese Government since the cession to them of Formosa, whence the largest quantity and best quality of camphor is derived. The production in 1900 is said to have been 134 tons in Japan, 98 tons in China, and 2,680 tons in Formosa. But it is affirmed that Japan has effected an agreement with China whereby she exercises a preponderating influence over the export of camphor from Chinchew (Fukien) on the Chinese mainland, which formerly shared the Indian and European trade with the province of Tost in Sikok (Japan) and the Eastern or aboriginal districts of Formosa. [*Cf.* Pickering, *Pioneer. Formosa*, 1898, 202, 220.]

For a description of various processes of refinement the reader may consult the article given in the *Dictionary*. Herren Tschirch and Shirasawa published a careful account of the formation of this camphor, and Bamber (Lecture May 14, 1906, delivered before the Ceylon Agricultural Society) gives particulars of the still that should be used. [*Cf. Archiv. der Pharmacie, Berlin*, 1902, No. 46; *Kew. Bull*, 1899, 57–68; 1907, 88–90.]

Bornean and Sumatran.

Dryobalanops aromatica, *Gaertn., f.*; *D. Camphora*, *Colebr.*, *As. Res.*, 1816, xii., 535–41 and pl.; Gamble, *Man. Ind. Timbs.*, 69; DIPTEROCARPEÆ. Bornean and Sumatran Camphor. A lofty tree, native of the north-west coast of Dutch Sumatra, North Borneo and Labuan.

Barus Camphor.

Old Trees Best.

In the stem are formed coarse crystals which constitute the BARUS CAMPHOR called in Indian trade returns *bhimsaini* or *baras*. The crystals are often found in concrete masses in the heart of the tree, or in the knots and swellings where the branches issue, but camphor is also found beneath the bark. To obtain the product, which is valued by some of the Chinese at from 40 to 80 and even 100 times the price of ordinary camphor, the tree is destroyed and cut into small splinters. An average tree is said to yield about 11 lb., but the old trees are the most remunerative, and only about 10 per cent. of those destroyed really repay the labour. This camphor is used by the Malays for embalming and for ritualistic purposes, and is well paid for. Probably the camphor first known to the world was obtained from this tree, and not from ***Cinnamomum Camphora***. [*Cf.* Flückiger and Hanbury, *Pharmacog.*, 458; Gildemeister and Hoffmann, *Volatile Oils*, 370–7, 502.]

Ngai Camphor.

Other Camphors are obtained from several plants, as for example thyme, patchouli, tobacco, etc., etc., but the production from these sources would appear not to be a paying industry. The widespread reputation of ***Blumea Balsamifera*** as a source of NGAI CAMPHOR is probably delusive, so far at least as India and Burma are concerned, though the leaves would appear still to be employed for the distillation of a powerful camphor in Upper Tonkin. [*Cf. Kew Bull.*, 1895, 275–7; 1896, 73; Bhaduri, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1902–3, 29; *Bull. Econ. L'Indo-Chine*, 1903, vi., n.s., 512.]

Production

Synthetical Camphor.

Production.—The camphor monopoly established by Japan had the effect of raising the price of the natural product, and this led to the fairly successful synthetical fabrication of the commodity in America. It would be beyond the scope and purpose of this work to do more than indicate the directions and possibilities of the camphor industry, and it must suffice therefore to state that it can be and is being produced

Expectations not fulfilled.

chemically. But the rise in the price of camphor has had another effect, namely of turning the attention of planters in other lands to the possibility of competing with Japan in the supply of natural camphor. Willis and Bamber in an able article have dealt with every aspect of cultivation and manufacture (*Circ. Roy. Bot. Gard. Ceylon*, 1901, No. 24). In *The Agricultural Ledger* (1896, No. 5) Hooper detailed certain experiments which went to show that a fairly large supply of camphor might be obtained from an oil distilled from the leaves of ***Cinnamomum Camphora.*** It had been supposed that camphor was only obtainable from the timber and roots of trees 50 to 100 years old, and obviously only Governments could undertake to plant such on a large scale and wait so long for remuneration; but as a consequence of experiments made in India, Algeria, United States and some German colonies, it was thought that ***Cinnamomum Camphora*** might be planted as a catch crop by tea, coffee and indigo planters. The results, however, do not appear to have justified the hopes that were once formed. It would be beyond the scope of this work to deal with the European uses of camphor, but it may be mentioned that one of the most interesting is its employment in the manufacture of celluloid. [*Cf.* Heuzé, *Les Pl. Indust.*, 1895, iv., 269–72; *Kew Bull.*, 1895, 305; *Trop. Agri.*, April 1, 1904, 659; Komppa, *Pharm. Journ.*, lxxii., 77; Gallenberg (reviewed) in *Capital*, June 4, 1903; Collins, *Scient. American*, lxxxix., 368; *Madras Weekly Mail*, May 9, 1903; March 20, 1905; Hauxwell, *Rept. For. Admin. N. Circ. Burma*, 1901–5, 52; Copleston, *Notes on Cult. Camphor*, in *Agri. Journ. Ind.*, 1907, ii., pt. i., 92–4.]

Commerce and Trade.

Refining Industry.

Trade with Japan.

Commerce and Trade.—India possesses a fairly large industry in the refining of camphor, chiefly at Bombay, Delhi, etc. The refiner sells the article at nearly the same price as he purchased it for, the profit being made on its mechanical absorption and retention of a large amount of water. It appears, however, that an increasingly large proportion of Japanese camphor is sublimed before being exported to India. The imports of Barus camphor are now of little or no consequence, having decreased from 528 lb. in 1899–1900 to 106 lb. in 1903–4, and in value from Rs. 32,898 to Rs. 3,170, and in 1906–7 were *nil.* The total amount of other camphors imported was 1,071,714 lb., valued at Rs. 9,96,336, in 1899–1900; 1,091,002 lb. at Rs. 12,97,482 in 1903–4; 1,169,238 lb. at Rs. 16,17,043 in 1904–5; 703,716 lb. at Rs. 13,37,938 in 1905–6; and 849,261 lb. at Rs. 22,99,783 in 1906–7. In the first-mentioned year Japan contributed only 135,010 lb., valued at Rs. 1,82,680; whilst in 1903–4 the amount was 671,220 lb. at Rs. 8,42,391; and in 1904–5, 856,130 lb. at Rs. 12,51,846; though it fell off in 1906–7 to 426,007 lb. at Rs. 14,11,926. Doubtless a large proportion of this must be the Formosan camphor, which was previously exported to India *viâ* Hongkong. The increase in the Japanese trade corresponds with a rapid decrease in the quantities obtained from the United Kingdom (English refined camphor), Hongkong and the Straits Settlements, the totals for these three having been in 1899–1900: United Kingdom, 84,460 lb. valued at Rs. 77,658; Hongkong, 440,458 lb. at Rs. 3,80,598; Straits Settlements, 411,696 lb. at Rs. 3,55,261. In 1906–7 the quantities and values were respectively: United Kingdom, 22,311 lb. at Rs. 76,778; Hongkong, 277,360 lb. at Rs. 5,43,304; Straits Settlements, 74,803 lb. at Rs. 1,61,295. The increased proportionate value of Japanese camphor compared to European camphor may show that more of it is imported in a refined state. The re-exports manifest an increase from 38,517 lb. at Rs. 38,375 in 1899–1900 to 121,023 lb. at Rs. 2,14,369 in 1905–6. In 1906–7 they fell, however, to 44,776 lb. at Rs. 1,01,132. Bombay and Bengal are the chief ports of departure, and Natal is ordinarily the best customer, though since 1904 the United Kingdom has stood first.

Oil of Camphor.

Oil of Camphor.—There are two very distinct substances known by this name. One is the oleo-resin of Borneo, obtained by distillation of the wood or by tapping the trunks of ***Dryobalanops Camphora***, which, being unable to resist the pressure of the fluid, sometimes burst open or have their tissue broken into large internal chambers. According to Gildemeister and Hoffmann (*Volatile Oils*, 503) this oil is not obtainable on the market. The other so-called camphor-oil of Formosa and Japan is a brown liquid holding in solution much common camphor, which is precipitated when the temperature of the liquid falls. The crude oil is made by distilling chips of camphor-wood in water. After removal of the camphor which crystallises out on cooling, it represents a transparent bright-yellow to brownish-yellow liquid oil having a penetrating odour. In Formosa it was formerly thrown away as worthless, but the Japanese used and still use it to a considerable extent in connection with lacquer and varnish-work, besides extracting a considerable residue of camphor from it. A long and interesting paper on the various qualities of camphor-oil together with a description of the method of extracting refined camphor therefrom and of manufacturing *safrol* from the "red oil" (crude oil after the removal of the essential white oil and camphor) will be found in *Schimmel & Co.'s Semi-Annual Report* (Oct.–Nov., 1902), being taken in part from the *Journal of the Pharmaceutical Society of Japan* (April, 1902, No. 242). It would appear that the camphor is now extracted in Japan, whereas the oil was previously exported in a crude state, largely to Germany. [*Cf.* Shimoyama, Acc. in *Trop. Agrist.*, Nov. 1901, xxi.]

Safrol.

[*Cf. Paulus Ægineta* (Adams, Comment.), iii., 427; Marco Polo, 1298 (ed. Yule), ii., 241; Varthéma, *Travels*, 1510 (ed. Hakl. Soc.), 248; Garcia de Orta, 1563, *Coll.*, xii.; Ball, Comment. in *Proc. Roy. Ir. Acad.*, i. (ser. 3), 398; *Ain-i-Akbari*, 1590 (Blochmann, transl., 1873), i., 78–9, 385; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), 1598, i., 112, 120; ii., 67, 117–8; Birdwood and Forster, *E.I.C. First Letter Book*, 58, 289; Foster, *E.I.C. Letters*, iii., 240, etc.; iv., 5–8; vi., 73; Cocks, *Diary*, 1623, ii., 343; Piso, *Mant. Arom.*, in *Ind. Utri. re Nat. et Med.*, 1658, 165–8; Breyn, *Pl. Exot.*, 1678, Cent. i., 11–7, *Icon*, 2; Milburn, *Or. Comm.*, 1813, ii., 307, 500; Bennett, *Wanderings N.-S. Wales*, 1834, i., 175; Wiesner, *Die Rohst. des Pflanzenr.*, i., 544; Dewey, *U.S. Dept. Agri.* (Botany) *Circ.*, 1897, No. 12; *Der Tropenflanzer*, ii., 87; iii., 555–6; iv., 202, 415; *Journ. Linn. Soc.*, xx., 414; *Camphor Indust. for Ind.*, in *Ind. For.*, 1900, xxvi., 284; Mukerji, *Handbook Ind. Agri.*, 1901, 435–8; *Dipl. and Cons. Repts. Japan*, 1903–4, iii., 29; *Journ. Soc. Chem. Indust.* (many passages); *Pharm. Journ.* (many *Trop. Agri.* (many passages).]

D.E.P., ii., 94 6.
Black Dammar.

CANARIUM, *Linn.*; *Fl. Br. Ind.*, i., 531–6; BURSERACEÆ. There are about 9 species in this genus, all large trees, and several of them afford useful resins. Considerable confusion exists, however, regarding their respective products, so much so that the most satisfactory course is to assort the available information geographically.

C. bengalense, *Roxb.*, is the *nerebi* of Sibsagar and Sylhet of which Roxburgh wrote, "From fissures or wounds in the bark, a large quantity of a very pure, clear, amber-coloured resin exudes, which soon becomes hard and brittle, and is not unlike copal, yet the Natives set no value on it." "In the Calcutta bazar, it is only valued at from 2 to 3 rupees for 7 maunds of 80 pounds weight each." Most writers have repeated the above without either correcting or amplifying the information, so that it is not known whether or not the resin is used economically.

C. commune, *Linn.*, is the Java almond and the *rata-kekuna* of Ceylon. A large tree of the Malay, but cultivated occasionally in India and Ceylon.

C. resiniferum, *Brace*, is the *dhuna, dhua, tekreng*, etc. A large tree of Assam, the Khasia and Garo hills. It would seem highly probable that this is the chief source of the ***Canarium*** resin of Assam which has hitherto been mostly supposed to be afforded by ***C. bengalense***. Gamble says it gives a resin which

Torches.
Varnish.
Enamel Paint.

is used for torches. A sample of Assam resin, weighing over 13 lb., received by the Reporter on Economic Products as "a fairly average quality of the Black Dammar" was sent to the Imperial Institute, London, for examination and report. Dunstan replied that the results obtained "indicate that the resin is of the dammar type although it differs to some extent from the black dammar of commerce, stated to be derived from ***C. strictum***, especially in possessing lower acid and saponification values." Some varnish manufacturers to whom the resin had been supplied reported that it was suitable for the preparation of a hard drying varnish, such as is required for enamel paints, though the dark colour of the resin would prejudice its sale and it was not likely to fetch more than 18*s*. per cwt.

Gugal Dhup.

C. sikkimense, *King, Journ. As. Soc. Beng.*, lxii., pt. ii., 187; is the *gugal dhup, nar-ok-pa*, etc. A very tall tree of Nepal and Sikkim—the inner valleys of the Eastern Himalaya up to altitudes of 3,000 feet. It yields a clear amber-coloured brittle resin that is burnt in incense by the Lepchas. Dymock (*Journ. Bomb. Nat. Hist. Soc.*, 1891, vi., 409) speaks of an amber-coloured resin—the incense (*gokal-dhup*)—and he was thus doubtless speaking of this plant and not of ***C. bengalense*** as he supposed. ***C. sikkimense*** has of late years become a scarce tree, due apparently to the demand for tea-box woods. The timber is said not to warp but to decay rapidly.

Gugal.
Collecting Seasons.
Price.

C. strictum, *Roxb., Fl. Ind.*, iii., 138; Talbot, *List. Trees, etc.*, 1902, 70. The Black Dammar, *gugul, kula-dammar, karapu kongiliam, karang kunthrikam, kundrikam, manda dhup, raldhúp, thelli*, etc. A tall tree of Western and Southern India from the Konkan southwards. When in young foliage it is almost crimson and is in consequence very conspicuous on the Ghats, up to altitudes of 5,000 feet. It yields the resin known as the black dammar of South India. The timber is worthless, and to obtain the resin the trees are fired. Vertical cuts are made on the bark and a mass of brushwood thereafter fired around the base of the trunk. In about two years' time the dammar is said to begin to exude from the stem and to continue to flow for ten years afterwards, during the months of April to November. This is collected in January and traded in all over Southern and Western India, but owing to its high price is not much exported. The supply comes chiefly from Travancore and the resin fetches about Rs. 3 per 18 lb. It is employed in the manufacture of a bottling wax or for varnish, etc., and in medicine as a substitute for Burgundy pitch in the manufacture of plasters. Full particulars of the chemical properties and medicinal uses will be found in the *Dictionary*. The substance was examined and reported on by the late Mr. Broughton. [*Cf.* King, *Journ. As. Soc. Beng.*, 1893, lxii., 184–8, tt. 10–3; Gamble, *Man. Ind. Timbs.*, 140–1; Cooke, *Fl. Pres. Bomb.*, i., 201–2; Brandis, *Ind. Trees.*, 130.]

D.E.P.,
ii., 97.
Sword
Bean.

CANAVALIA ENSIFORMIS, *DC.*; *Fl. Br. Ind.*, ii., 195; Wight, *Ic.*, iii., t. 753; Duthie and Fuller, *Field and Garden Crops*, pt. iii., pl. lxxi; Cooke, *Fl. Pres. Bomb.*, i., pt. ii., 372; Prain, *Journ. As. Soc. Beng.*, 1897, 66, 418; also *Beng. Plants*, 1903, i., 394; Duthie, *Fl. Upper Gang. Plain*, i., 235; LEGUMINOSÆ. The Sword Bean or "Overlook," sometimes called Patagonian Bean, *shimbi, kadsambal, mekhun, makham-shim, sem, sufed-sem, tihon, abai, gavari, segapu, peh-naing-ni*, etc.

French-beans.

A perennial climber cultivated throughout India, from the Himalaya to Ceylon and Siam, common in gardens or on the borders of fields and over the roofs of huts. The young and half-grown pods constitute the so-called "French-beans" of Europeans in India, but they are also eaten by the Natives, especially in curry. Some five kinds, probably only races, are reported to be grown, of which the form known as *hilwa*, a white narrow-podded condition, is considered the best. The mature seeds are said to be eaten fairly extensively in Mysore and in some parts of the Bombay Presidency. By the Muhammadans, here and there all over India, they are appreciated as a vegetable and eaten along with meat, especially that of the white-seeded form. There are three wild species, viz. ***C. virosa**, W. & A.* (*kath-shim, kala-shim*), very plentiful throughout India and by some writers regarded as the origin of the cultivated plant. It has been reputed to be poisonous. ***C. lineata**, DC.*, a littoral species creeping along the sand, and ***C. obtusifolia**, DC.* (***C. ensiformis**, var.* ***turgida***), a common climber along the banks of tidal creeks and rivers.

CANNABIS OR HEMP

CANNABIS SATIVA, *Linn.; C. indica, Lamk.*; *Fl. Br. Ind.*, v., 487; Rheede, *Hort. Mal.*, 1690, x., pl. 60–1; Rumphius, *Herb. Amb.*, 1750, v., 208–11, pl. 71; Roxb., *Fl. Ind.*, iii., 772; Duthie and Fuller, *Field and Garden Crops*, 1882, pt. i., 80–1, tt. xix., xx.; Prain, *Morphol., Teratol., and Diclin. of Flowers of Cannabis*, in *Scient. Mem. Offic. Med. and San. Dept., Ind.*, n.s., 1904, No. 12; URTICACEÆ.

D.E.P., ii., 103–26.
Hemp.

Vernacular Names.

The following may be given as the more important names:—Hemp (fibre), Indian-hemp (the narcotics), Canvas (coarse textile), English; *cannabis*, Greek and Latin; *canaib*, Keltic; *kanas*, Modern Breton; *chanvre*, Fr.; *canamo*, Sp.; *canhamo*, Port.; *canape*, It.; *canapa*, Ruman.; *canep*, *kerp*, Albanian; *konople*, Rus.; *konopj*, *penka*, *pienka* and *penek*, Polish and Old Slav.; *kemp*, Belg.; *hampa*, *hamp*, Swed. and Danish; *hanf* or *hanaf*, Old High Germ.; *hampr*, N. Germ.; *knapios*, Pruss.; *Hanfr*, Iceland; *hennup*, *kennip*, Dutch; *kenevir*, Bulg.; *kentyr*, Tartar; *kant*, Erse; *kanaq*, Armen.; *schema*, Mughal; *dschoma*, Tanjut; *nasha*, *asarath*, *malach*, Turk.; *kin-dur*, Turko-Tart.; *kirs*, Bokhara; *kandir*, Kashgar; *kanabira*, Syrian; *kinif*, Kurd.; *kief*, Morocco; *ta-ma*, *si-ma* (great or male) and *tsu-ma*, *chu-ma* (seed-bearing or female), Chinese; *asa* (the plant and fibre), *nuno* or *jofu* (the hempen cloth), Japanese; *bhangá*, *vijayá*, *indrasana*, Sanskrit; *bhang*, *beng bháng*, *haschisch*, *siddhi*, *sabzi*, *ganja*, *charas*, *majún*, *jia*, *kas*, Hind., Beng., Nepal, Pb., C. Prov., Kach, Guj., Deccan; *siní*, *sirín*, Sind; *ganjáyi*, *korkkar*, *kalpam*, Tam. and Tel.; *gingi-lacki-lacki*, *ginjil-achi-lachi*, (*kalengi-cansjava* (male) or *bhangi*, etc., of Rheede, *gingi* of Rumphius), Malay; *kinnab*, *hinab*, of younger Serapion, *schehedenegi* in Matthiolus, and *axis* or *assis* in Acosta, Linschoten, Rumphius, etc., Arabic (*axis*, *assis* are doubtless the Arabic *haschisch*): *dakka*, *docha*, Hottentot; and *riamba*, *diambe*, or *jamba*, W. Africa (Negro); *darakhte-kinnab*, *bang.*, *nabatul-gunnab*, Persian; *bhén*, *sejav*, Burmese; *matkansha*, *ganja-gaha*, Sinhalese; *ahets-mangha*, *rongoyne*, Madagascar.

Habitat.

Habitat.—The Hemp plant grows in a wild or spontaneous state over so wide an area, but at the same time is always so closely associated with places that are or may have been inhabited or used as trade routes, that it is difficult to say where it originated. The widest range claimed for wild hemp covers the area from Trans-Baikal and Dahuria westward and southward to Bokhara, the Trans-Caspian province, Russia south of the Caucasus, and, according to Hooker, the North-Western Himalaya. It is, however, as plentiful in an acclimatised state in Japan and Northern China, and in the Sub-Himalayan zone of Northern India, as in any part of the region indicated, though it is admittedly there only a plant of waysides and waste places. Having regard to the value of the situations it affects, Prain, in his report on ganja, does not regard it as indigenous either in India proper or along the North-West frontier. But even in some of the Siberian districts accepted as part of its original home, it has been noted as occurring near dwellings, and Gmelin (*Fl. Sibir. Hist. Pl.*, 1768, iii., 104) seems to believe it to be wild simply because the Buriats and Krasnoiar Tatars do not actually sow it. The arguments against its being wild in Northern and Central Asia are thus almost as strong as in the case of Eastern and South-Eastern Asia. So far as India is concerned, the conclusion of the Hemp Drugs Commission is probably correct, namely that it is not indigenous.

Not Indigenous in India.

Products.

Properties and Uses.—The hemp plant is known to yield three distinct products, or perhaps rather groups of products, separately dealt with in this work:—

A BAST FIBRE, largely employed in the manufacture of cordage ropes and coarse textiles. **Fibre.**

An EDIBLE SEED, from which a useful fatty OIL is expressed. **Edible Seed.**

A NARCOTIC resinous substance that appears in trade in three chief **Narcotic.**

forms, known as *bhang*, *charas*, and *ganja*, and which chemically consists of a resin and a volatile oil.

Bhanga.

Male and Female Plants.

"Charle" or "Steele."

"Fimble Hempe."

The word *bangra* is given in Nepal to a coarse cloth made from the nettle ***Girardinia heterophylla*** and in Sikkim a similar textile bears the name *gunnia*, while in Burma the name *gun* or *gwon* denotes ***Boehmeria nivea***. and in Bengal the fishermen's nets made of *rhea* fibre are called *gangajalu*. A coarse cloth made in Mysore from ***Crotalaria*** is also named *gunj*. It is thus somewhat surprising that in India the best-known nettle fibres, including hemp, bear names that have the sound of *bhanga* or *ganja* (though possibly quite unconnected). Christopher Acosta (*Tract. de las Drogas*, 1578, 359–61) figures and describes the "*Bangue*." Mandelslo (*Travels*, 1662, 37) speaks of "*Bengi*," a drug made from hemp. Fryer (*New Acc. E. Ind. and Pers.*, 1672–81, 126) mentions "a Fakier drunk with Bang" whom he saw in Surat. On the Himalaya, where ***Cannabis sativa*** is grown for its fibre, the male plant is called *phúl bháng* and the female *gúl*—or *gúr-bhánga*. At Indore the male plant is *hari* and the female *bhamgera*. Very nearly throughout the world wherever hemp is cultivated the larger and more prolific plant has been taken as the male (though as a matter of fact it is botanically the female). Prain informs me that he believes, with the Mongolian races, the sexes are not as a rule reversed. The names given to the two forms or sexes are therefore interesting. From Gerarde (1636) we learn that in his time English writers spoke of the one plant as the "Male" and called it "Charle" or "Steele Hempe" (p. 1083), or "Winter Hempe," and of the other as the "Female" (or, as he calls it, Femeline, botanically the male), the "Barren Hempe" or "Summer Hempe," and by more recent writers "Fimble Hempe." Gerarde makes an interesting observation in this connection :—"There is another, beeing the female Hempe, yet barren and without seed, contrarie unto the nature of that sex ; which is very like to the other beeing the male, and one must be gathered before the other be ripe, else it will wither away and come to no good purpose." The corresponding German names are *Fimmel* (male) and *Maschel* (female). It is, however, significant that in none of the prehistoric remains of Europe has hemp been found, though flax is frequent. [*Cf.* O. Schrader, *Reallexicon, etc.*, 330–1.]

Removal of the Males.

Oil.

Winter Hemp.

Summer Hemp.

eason of aturity for ibre.

ouble Crop.

But Gerarde's observation regarding the necessity to remove the male plants (the "females," as he calls them) because otherwise the crop may come to no good, is curiously suggestive of the Bengal practice, that will presently be explained. As a matter of fact, however, it is the general custom in Europe to remove the male (or, as it is called, "female") plants some 20 to 40 days before the female (male) is harvested, the reason being that after the dissemination of the pollen the male plants rapidly mature, so that long before the females have formed their seeds the fibre in the male stems has been ruined. Similarly, if the seeds be allowed to ripen, the fibre of the female plants will also be ruined. It accordingly is the custom to harvest the female crop when in a half-ripe condition, that is to say, the seeds have not been fully matured but they are at that stage rich in oil and thus afford a by-product of no small importance. Still further, it seems the custom, in some parts of Europe, to store the stems for a time before separating and cleaning the fibre. The fibre cleaned in winter is accordingly called Winter Hemp and that retted in spring and cleaned finally in summer is described as Summer Hemp. But like the names "male" and "female," the terms "summer" and "winter" are often inverted. Lastly, the greatest possible confusion exists in the literature of this subject as to whether or not the botanically male plant yields a fibre, and, if it does, its relative value to that of the female. [*Cf.* Crawford, *Indust. of Russia, Agri. and Forest*, 1893, 139–43 ; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, i., 520, ii., 300.] Wilson (*Farm Crops*, 1859, ii., 325–43) gives what is doubtless the complete statement when he observes that the plants flower in about twelve weeks after the date of sowing, "and then is seen the peculiarity of the cultivation of hemp as compared with other crops. If the crop be intended for fibre only, the harvesting generally takes place as soon as the process of flowering is completed, and both male and female plants are pulled at the same time and treated in the same manner. When, however, the double produce of fibre and seed are desired, a different method is pursued, by which the full produce of the crop is secured." The male plants are pulled up by the roots, care being taken not to injure the female, which are left on the field for a further period. "The male plants are collected and tied in small sheaves, and either left standing in a convenient place till dry or at once taken to the retting vats." Morris

Male *versus* Female Fibre.

Soil and Climate.

(*Cantor Lect., Journ. Soc. Arts*, 1895, 901) says the fibre of the male plant is tougher and better than that of the female. It is separated by retting, breaking and scutching as in flax. [*Cf.* also Dodge, *Cult. of Hemp and Jute, U.S. Dept. Agri. Fibre Investig. Rept.*, 1896, No. 8.] In New Jersey experiments were conducted to test the influence of environment on the relative production of male and female plants. On rich soils twice as many female as male plants spring from the seeds. So also seed collected late in the season was found to give more pistillate than staminate plants.

Wild Hemp.

Confusion with other Fibres.

Sanskrit Literature.

Turning now to the mistakes made by Gerarde and most of the early writers regarding plants supposed to be wild states of ***Cannabis sativa***, it may be observed that in the classic literature of this subject in Europe, India and China, exactly parallel examples of error may be cited to those of the 13th to 18th century writers. In India from the time of the early Mughal Emperors, at least two, if not three fibre-yielding plants have been recognised as forms of hemp, viz. *bhangá* or *sana* (***Cannabis sativa***), *patsan* (***Hibiscus cannabinus***), and *san* (or *sunn*) (***Crotalaria juncea***). The first two are mentioned, for example, in the *Ain-i-Akbari* (1590, Blochmann, transl., i., 87) in such terms as to leave no doubt as to the palmate-leaved *san* having been recognised as distinct from the yellow-flowered *san* of another passage (Gladwin, transl., i., 101). But while *sana* —a fibre—occurs in the *Institutes of Manu* (probably of date 100 to 500 A.D.) and in some of the later Sanskrit works, it apparently denotes ***Crotalaria*** rather than ***Cannabis***. It would thus seem as if the word *sana* to denote the true hemp had been a comparatively modern usage.

Hemp in China.

History. The names *schema* and *deschoma* given to it, according to John Ammanus (*Stirp. Rar. Imp. Ruth.*, 1739, 174), in Dahuria, are suggestive of the Chinese *ta-ma* (great-*ma*), *si-ma* (male-*ma*), *tsu-* (sometimes written *chu-*) *ma* (female and seed-bearing-*ma*). Bretschneider says "the character *ma*, which nowadays is a generic term for plants yielding textile fibres, was in ancient times applied exclusively to the common hemp plant ***Cannabis sativa***, *Linn.* It would, in fact, seem fairly certain, if the plant be excluded by botanists from the position of being regarded as indigenous to China, it has been frequently mentioned in the *Rh-ya*, and special characters are employed to denote the fibre plant as distinct from the seed-bearing form. In fact it would seem that so very ancient is the character *ma* that it denotes conjointly fibre and oil (or food). Dr. Henry has pointed out to me that the character in question looks not unlike two plants within a partially protecting line. Whether or not the very character used to denote *ma* was intended to convey the idea of the two forms, the double property was certainly known from the most ancient times. [*Cf. Kew Bull.*, 1891, 247-59.] Bretschneider accordingly observes :—" As hemp-seed was an article of food, hemp in ancient times was reckoned as one of the five, or nine, kinds of grain." The *Lu Shi* (Sung dynasty) relates a tradition according to which the Emperor Shen Nung (28th century B.C.) first taught the people to cultivate the *ma*.

Indian Classic References.

Discussing the classic names associated with India, G. A. Grierson (*Note on the References to the Hemp Plant occurring in Sanskrit and Hindi Literature*, in *H.D.C.R.*, iii., 246) mentions *bhanga*, *indráçána* and *vijayá* or *jayá*. "The name *bhanga* occurs in the *Atharvavéda* (say 1400 B.C.). The hemp plant is there mentioned simply as a sacred grass." It was one of the five herbs offered in oblations, viz. *soma*, *kuca*, *bhanga*, barley and *saha*. "The first mention of *bhanga* as a medicine which I have noted is in the work of *Susruta* (before the 8th century A.D.), where it is called an antiphlegmatic. During the next four centuries *bhangá* (feminine) frequently occurs in Native Sanskrit dictionaries in the sense of hemp plant." "In the 10th century the intoxicating nature of *bhang* seems to have been known: and the name *indráçana*, Indra's-food, first appears, so far as I know, in literature. Its intoxicating power was certainly known in the beginning of the 14th century." The synonym *vijayá* (the giver of success) often has the alternative meaning of *harítaki* (***Terminalia***). Dutt (*Mat. Med. Hind.*, 1900, 235-41)—a great authority on the Sanskrit names of plants—says a mythological origin has been invented for this plant. It is reputed to have been produced in the shape of nectar while the gods were churning the ocean. In part confirmation of that view it may be mentioned that in the medical treatise that constitutes *The Bower Manuscript* (translated and annotated by Dr. A. F. Rudolf Hoernle) no mention is made of Indian hemp in any form. The MS. was found at Kucha, Khotan, which according to Stein was engulfed by sand towards the close of the 8th century. It is thus

Intoxicating Property known.

Magic Plant.

very possibly the oldest Indian MS. of a medical work extant. But in the *Pharmacographia Indica* the following occurs, " It is mentioned along with the Vedic plant *janjida*, which has magic and medicinal properties and which is described in the *Atharvavéda* (ix., 34, 35) as a protector." " The gods are said to have three times created the herb (*oshadhi*)." " The intoxicating properties which the plant possesses in its Eastern home appear not to have been discovered until a more recent date, but in the fifth chapter of Manu, Brahmins are prohibited from using it, and in the sacred books of the Parsis the use of *bana* for the purpose of procuring abortion is forbidden." It may, however, be pointed out that the authors of the *Pharmacographia Indica* would perhaps have been more correct had they stated that the magic plant was called *sana* not *bhanga* and was spoken of as springing from the saps of husbandry—it was therefore a cultivated plant and one possibly of moist soils. On the other hand, Dr. Krishna Garde of Poona, in his evidence before the Hemp Drugs Commission (vii., 173–9), stated in the most emphatic manner that in the ancient classic literature of India there was " not the slightest reference, direct or implied, to the narcotic properties of the plant."

Panini's Definition.

Panini, he continues, " refers to it as cultivated in fields (evidently for its fibre and seed). Manu and Kaushitaki Brahmana refer to it as a source of fibre. Later Sanskrit commentators and lexicographers interpret *bhang* as *shana*, the Bengal *sunn* plant (**Crotalaria Juncea**), which has been known in India from time immemorial as a plant-yielding fibre." There are no Sanskrit names for *ganja* or *charas*; all the words so used, according to Dr. Parker, have been recently coined. In the " Sabha Parva " of the *Mahabharata*, the Sakas (Scythians of Turkestan) are spoken of as bringing presents of thread spun by worms and *patta*. In that reference apparently the fibre of hemp may have been denoted, but it was not called *sana* but *patta*.

First Mention of *Ganja*.

Grierson (in his communication to the Hemp Drugs Commission) observes that the first reference to *ganja* which he has noted is about 1300 A.D. He then adds that according to an old Hindu play written in the beginning of the 16th century Siva himself brought down the *bhang* plant from the Himalaya and gave it to mankind. Jogis are well-known consumers of *bhang* and *ganja*, and they are worshippers of Siva. In this connection also it may be explained that Grierson has permitted me to re-submit to him personally the controversy regarding the *bhangā*, *ganja* and *sana* of Sanskrit literature. While he diffidently urges that comparative philology is out of his line, he points out that if it be accepted that *bhanga* is an Aryan (not a Semitic word as Burton suggests), it is derived from *bhanj*—to break (transitive). In that sense it occurs not infrequently in names of plants other than **Cannabis**, such as *gátra-bhangā* (= body-breaking), *katu-bhanga* (= pungent *bhanga*); so also in certain combinations such as *prishtha-bhangā* (= back-breaking—a trick in wrestling). But if the derivation from *bhanj* be correct, then the " breaking " might refer to the senses and have the meaning of " to rout."

Bhanga from *Bhanj*.

The Indian *bhanga* and the Avesta *banha* (the Persian *bang*) have a common origin and the " bh " form is the original. The reverse is improbable if not impossible. The nearest certain common root is the Sanskrit *bhanj* already mentioned (suggestive of a hypothetical *bhranj*, and of *frangere*, *brechen*, break, etc.). [*Cf.* Hehn, *Kulturpfl. und Haust.*, 471–2.] The word *bhanga* has both a male and female form, a circumstance suggestive of the botanical male and female plants, and if so that fact might be viewed as removing it from *sana* (which usually denotes **Crotalaria Juncea**).

Sana.

Commenting on the word *sana*, Grierson says its origin is unknown to him but that the cerebral " n " suggests a previous " rn." It can have nothing to do with *indra-asana* (Indra's-food). Prain, on the other hand (*Cult. and Use of Ganja*, 1893, 43), regards *śána* as the most interesting of the Sanskrit names for this plant. Prof. Rapson writes me that it is quite possible the original form of the word was *κανναβ-ις*, hence the numerous Teutonic names like the English " hemp " and the early English " henep." The Greek and Latin " k " often changes into " h " and the " b " into " p " on passing into English. But if this be so, the final " b " was dropped off in Sanskrit—the *śaṇa* may have been originally *śanab*. The sound-changes involved are quite regular, namely the Sanskrit " ś " (the palatal sibilant) passing into the Greek and Latin " k " sound, and then into the English " h."

Greek Cannabis.

But O. Schrader (*Reallexicon der indogerm. Altertum.*, 1901, 331) observes that the *bis* or *pis* in the Græco-Thracian *κανναβις* is suggestive of *pis*, *pus*, the (Finnic) Siryenian and Votiak word for nettle, so that the original may have been *καννα-βις* and meant hemp-nettle.

[*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 207; Roxb., *Obs. Hemp and Flax Substitutes*, 1801; Baden-Powell, *Pb. Prod.* 1868, 292-3, 377, 504-7; Hem Chunder Kerr, *Cult. and Trade in Ganja*, 1877; *Ganja and Other Drugs in Ind.*, Parliam., Paper, March 3, 1893; *Pharmacog. Ind.*, 1893, iii., 318-37; *Rept. Ind. Hemp Drugs Comm.*, 1894, 7 vols. (abbreviated into *H.D.C.R.*); Prain, *Rept. Cult. and Uses of Ganja*, 1893; *Imp. Gaz., Ind.*, 1904, iv., 259-61; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 77-81.]

I. THE FIBRE HEMP. (Seed, pp. 256-7, and Narcotics, pp. 258-63.)

Hemp Fibre.

Cultivated and Wild States of the Plants.—The remarks already made regarding the male and female conditions of ***Cannabis sativa*** have indicated some of the chief opinions that prevail in Europe regarding methods of cultivation. It has moreover been incidentally implied that in India, hemp is grown for either of two main purposes: (*a*) the supply of the narcotic; (*b*) the production of fibre. It is, however, very generally admitted that in the plains of India, while the narcotic principle is readily developed, the fibre is as a rule but very imperfectly formed. In many reports it is affirmed that certain forms of hemp contain a stronger or a better flavoured narcotic than others, circumstances explained by some authorities as being consequent on more careful preparation. [*Cf. Kotah State Mem.*, *H.D.C.R.*, app. iii., 178.] Prain says, "*Bhang* is held in very different degrees of estimation according to the locality in which it is grown; that from the plains is valued more highly than that from the submontane tracts along the Himalaya." On the North-West Himalaya the plant is fairly extensively cultivated, however, as a source of fibre, the narcotic being but indifferently produced. In some localities *ganja* is said to be obtained, in others *charas*, in a third *bhang*, while in Sind it is reported that the plant affords a good fibre as well as a fair quality of *bhang*. These peculiarities are not, however, by recent opinion accepted as involving conditions that are even racial in value, but are viewed as the direct results of climatic and soil influences. Prain, moreover, remarks, "We must conclude that, having reached India as a fibre-yielding species, the plant developed the narcotic property for which it is now chiefly celebrated there." So also the H.D. Commissioners in their Report (i., 17) observe, "The function of the Commission is to test by the information they have collected the views therein expressed regarding the probable existence of races capable of yielding as a speciality the different products—fibre, *ganja*, *charas* and *bhang*. The only differences recognised in the plant by the people are between the *wild* and the *cultivated* plant, the *male* and the *female* and the *varieties* of the male and female plants already referred to." Summing up, the Commissioners, however, observe that "there is no evidence of racial speciality or differentiation of the decided sort suggested" by some writers. Similarly it may be pointed out that Roxburgh was apparently much impressed with the absence of distinctive varieties. "Few vegetables," he remarks, "so widely diffused over almost every part of the known world, and under the immediate management of man, have undergone less change." (*Trans. Soc. Arts*, London, 1804, xxii., 385). It is thus certain the plant has varied structurally to a far less extent than might have been anticipated. But racial characteristics are not necessarily botanical manifestations, and that the plant has changed is at once evident by the widely different products which it affords. It has not as yet, however, been critically examined and compared province by province or the

Climatic Influences.

Change from Fibre-to Narcotic-yielding.

Differences recognised by the People.

Racial but not necessarily Structural.

field from the standpoint of the cultivator. Roxburgh was not aware, for example, that in Asia "the fibres of the bark have ever been employed for any purpose," so that he certainly had not studied all the racial forms that may have existed in India even in his time.

Two Forms in Kashmir.

In the Report issued by the H.D. Commission (i., 32), reference is made to there being two forms of the plant in Kashmir: "The *bhang*, which grows on both banks of the Jhelum below the city of Srinagar, is known as *kathiya bhang*, is weak in narcotic and is used only for its fibre and for burning. The wild growth is very abundant. It supplies all the wants of the people, and there is consequently no cultivation." So again (*l.c.* i., 30), doubt is thrown on the existence of the plant in Burma. It is probably not so plentiful in that country as in India.

Wild in Burma.

Pottinger and Prain, however (*Note on the Botany of the Kachin Hills, etc.*, in *Rec. Bot. Surv. Ind.*, i., 219), found it near the Kyeng-mo Kha, in the forests, and they add that the people appeared to have no knowledge of *ganja* and no idea that the plant possessed narcotic properties. But while Indian authorities thus throw doubt on the existence of cultivated forms of the plant, in Europe and America those engaged in the hemp industry have no hesitation in recognising many well-established races. Dodge, for example, says several varieties are recognised, such as that cultivated in Kentucky, having a hollow stem, the most common. Then there are the following forms: China, Smyrna, Common European, Bologne or Great hemp, the *canapa piccola* or small Italian, and lastly the Arabian. [*Cf.* Boyce, *Treat. on Cult. of Hemp., etc.*, New York, 1900.]

European and American Races of Hemp.

Early Experiments.—On more than one occasion public interest has been aroused as to the possibility of India becoming a source of hemp fibre. That the plant was completely acclimatised over the greater part of the plains and fairly extensively cultivated on account of its narcotic, are circumstances that have been cited in support of the contention that apathy and indifference had to account for India's backwardness in hemp production. During the closing decade of the 18th century the East India Company made various experiments on an extended scale. Roxburgh, in a letter dated Calcutta, 24th December, 1799, expresses somewhat piquantly his astonishment on finding a Mr. Sinclair sent from England to "establish the cultivation of hemp, a thing I had begun some time before." Sinclair seems to have died shortly after his arrival in India, but the experiments were continued for a few years. Speaking of *san*-hemp (*Crotalaria juncea*), Roxburgh wrote in his *Plants of the Coast of Coromandel* (1798, ii., 50, t. 193), "This useful plant yields the Hindoos their best hemp, for they have no idea of the superior quality of the bark of the common hemp-plant (*Cannabis*), which is indigenous in all parts of India; but of that plant they only use the leaves as an intoxicating drug. I have taken some trouble to teach the natives the use of a plant which hitherto they have only abused, by making some of their farmers witnesses to every part of the culture and preparation of the hemp, and which, on being compared with their *tschanamoo* hemp, they were perfectly convinced was infinitely better; at the same time the culture being equally easy, and the produce equally large, I have reason to think a few years will bring it into general use in these parts, and by degrees over India."

Complete Acclimatisation.

Roxburgh regarded it as Indigenous.

His Expectations.

In the early experiments European seed and European cultivators were alike imported, and every effort made to ensure success. Cultivation

Repeated Failures.

Himalayan Hemp.

and manufacture were carried on at Rishra, Cassimpore, Maldah, Gorakhpur, Mhow, Rohilkand, Azimgarh, etc., etc. The results were everywhere unsatisfactory. Still, however, inquiry and experiment were re-instituted in 1871, especially with regard to the fibre of the rejected stems from *ganja* cultivation; but the result was again unfavourable. The area of possible cultivation of hemp fibre was admitted to be that where it has from time immemorial been produced, namely the slopes of the warm temperate Himalaya. But it may fairly well be affirmed that the Himalaya as a possible extended source of supply has not been fully exploited. Recent and future increased facilities of transport may be looked to as giving openings for developing the trade in Nepal, Kumaon, Simla, Kullu and Kashmir hemp fibre. Some years ago the East India Company made contracts for Himalayan hemp (*H.D.C.R.*, app. iii., 26, 27, 231). For this purpose advances were made to the cultivators, and the fibre purchased at a fixed rate. The system worked well, and should a demand arise in the future, it might be resumed as the best mode of dealing with a community of very poor cultivators. [*Cf. N.W. Prov. Gaz.*, x., 799–805.]

Production.

CULTIVATION AND CHIEF LOCALITIES.—*Cannabis sativa* is grown as a source of hemp fibre in two localities: (*a*) the North-West Himalaya, including Kashmir, and to a much smaller extent in (*b*) Sind. The wild or fully acclimatised plant is called *jangli-bhang*, or *ganara-bhang*. Whether the two conditions—the wild and the cultivated—can be separately recognised seems doubtful; still it is a fact that the wild is useless, or nearly so, for either fibre or drug.

Two Forms.

Teoka.

Cultivation not Popular.

(*a*) ***Garhwal.***—The fibre-yielding plant grown in this district is met with on rich land having a north exposure. It is believed, moreover, that it would be impossible to give it too much manure. The small plots assigned to hemp are accordingly, as a rule, seen in immediate proximity to the cultivator's house, and are carefully protected. The crop does not succeed below 3,000, nor much above 7,000 feet in altitude. It is sown in May to June (about 60 lb. to the acre), and during growth the land is once or twice dressed, and where necessary the plants are thinned out so as to stand a few inches apart each way. By September to early in November the crop is ripe, and may then stand from 10 to 14 feet in height. The plants that bear seed are called *sujango* or *kalango*, and those that do not are *phulango*. The stems are cut with a sickle and spread on the ground to dry for 24 hours. Those who desire to procure *charas* (? *ganja*) now rub the fruiting tops and young leaves between their hands and thus procure the drug. The leaves are as a rule regarded as useless, but a small quantity may be collected, dried, and employed as *bhang*. The seeds are gathered, and constitute the second valuable product of the plant. The *kalango* stems are exposed to dry, and are in due course retted and the fibre separated and cleaned, as with the male stems (see p. 50). From the fine fibres of both plants the *teoka* or sheet worn by the people in Garhwal is prepared. Nearly one-third of the population of that district are clad in hempen garments. While that is so, it is remarkable that a certain odium is associated with the cultivation of the hemp plant, and hence only the low-caste farmers (*dóms*), or the half-caste Rajputs (Khasia-Rajputs) will grow it. [*Cf. H.D.C.R.*, v., 19, 20, 41–8, 76–8.]

Manufacture of String.

(*b*) ***Kumaon.***—A highly instructive account of the cultivation of hemp fibre in Kumaon will be found in the *Gazetteer of N.W. Himalaya* (1882, 760–7). The system pursued differs in no essential from that just detailed, and the objection to being classed as a "hemp-grower" also prevails. In the *Hemp Drugs Report* (*l.c.* i., 93) mention is made of the manufactures produced, which it would appear are fairly extensively exported from Almora to the plains. Owing to the usefulness of the plant its cultivation is said to have recently been considerably extended. The manufacturers of hemp string and rope are reported to be a special class of people called *boras* or *pajais*.

(*c*) ***Nepal.***—In this State the sowings are usually made a little earlier than in Kumaon and Garhwal—viz. from March to April, and the crop is accordingly ready in August. It would appear to be specially abundant in the hills from Maukamana to Redi, also in the Nepalese Terai. [*Cf. H.D.C.R.*, iii., 131; Kirkpatrick, *Acc. Kingdom of Nepaul*, 1811, 142–3; Buchanan-Hamilton, *Acc. Kingdom of Nepal*, 1819, 226, 231 2.]

Simla Hills.

(*d*) ***Simla and Kangra.***—A short notice of hemp fibre in Kotgarh will be found in the *Asiatik Researches* (1825, xv., 474, 478). One of the most interesting and useful accounts of the hemp cultivation of the Himalaya is that given by Baden-Powell (*Pb. Prod.*, 1868, 504–7). Stewart, in a correction on the text of his *Panjab Plants*, has recorded his final opinion that ***Cannabis*** was wild in the Panjáb hills, and speaks of it as cultivated up to 10,000 feet in altitude Coldstream says (*H.D.C.R.*, v., 365) it is not cultivated in the Panjáb for the production of *charas* or *ganja*. Useful additional particulars will also be found in the *Kangra Gazetteer* (1897, 78) and in Mr. Anderson's statement (*H.D.C.R.*, v., 379).

Grown for Two Purposes.

(*e*) ***Kashmir.***—In 1799 Captain Thomas Hardwicke visited Srinagar, and in the *Asiatick Researches* furnished an interesting narrative of his journey (vi., 376). He there observes that ***Cannabis sativa*** "is cultivated in several parts of the mountains for two purposes: one for the manufacture of a coarse thick cloth, which the poor people wear, and the other in making an intoxicating drug exported to the low countries." Lawrence (*Valley of Kashmir*, 69) tells us that about 600 maunds of fibre are annually produced in the country below Srinagar. Further particulars on this subject will be found in the *Hemp Drugs Report* (app. iii., 128). Many writers allude to the very superior paper that was formerly made in Kashmir from *bhang* fibre (*H.D.C.R.*, v., 438). Of Kyilang, the Rev. Mr. Heyde (*H.D.C.R.*, v., 487) informed the Commission that in British Lahul all the zamindars cultivate a small piece of ground, if possible, close to their houses, with hemp, solely in order to obtain fibre. This is made into strings, with which the straw shoes (*búla*) are sewn together. Very few people smoke *bhang*, and those who do, obtain their supplies from traders, who carry it from Yarkand to Hindustan.

Sind Hemp.

(*f*) ***Sind.***—Wild hemp known as *kohi bhang* is said to grow on the hills. The plant is cultivated on account of *bhang* (it does not yield *ganja* or *charas*) in this province, but the stems are occasionally utilised as sources of fibre, hence Sind being sometimes mentioned as producing the true hemp; at the same time the seeds are collected and eaten, or oil is expressed from them. Sir H. E. M. James, in his evidence submitted to the Hemp Drugs Commission (vii., 235), stated that the *charas* used in Sind is imported chiefly from Kandahar. The Deputy Collector of Naushahra (Witness, *l.c.* No. 4, 243) says, "In order to raise a good crop of hemp, it is necessary that the land should be well ploughed, manured, and copiously watered. The seed is sown in October or November, and the crop is ripe in April. According to another witness (Seth Vishindas Nihalchand, 291) the fibre is called *siní*. The stems are steeped in water for 15 days, after which they are taken out and then yield their fibre. But it may be asked—is it possible that ***Crotalaria juncea*** is the hemp fibre of at least some of the Sind reports? In South India, at all events, it would appear certain the fibre-yielding plant often spoken of **as** ***Cannabis sativa*** (*H.D.C.R.*, app. iii., 83) is in reality ***Crotalaria juncea.***

Trade in Hemp.

Trade in Hemp.—Russia still holds the foremost position in the world's supply of this fibre. The exports of hemp from India are mainly in *san*-hemp (***Crotalaria***), and the imports almost exclusively in Manila hemp. Hemp is regarded as resembling flax, but as possessing a higher tensile strength (30 to 35 as compared with 20 to 25 kilos per square mm.). It resists retting, and on that account is much valued for ropes and sail-cloth.

II. THE SEED AND OIL.

Seeds.

Edible Seeds.—Galen tells us that it was customary to give hemp-seeds to guests as a promoter of hilarity (*cum aliis tragematis*). Garcia de Orta speaks of the Indian seed being smaller and darker coloured than that of Europe. There is little doubt that the tendency for the seeds (fruits) to become agglutinated with the resinous narcotic is much greater in India than in most other countries, and this would seem to account

Their Occasional Narcotic Property.

Their Consumption along with other Grains.

Yield an Intoxicating Oil.

Volatile Narcotic.

for their being described as darker coloured. But it is no stretch of imagination to assume that it was the presence of the very minute particles of the narcotic that, in the story told by Herodotus, made the Scythians shout for joy while in their medicated vapour baths. Hove's description (1787) of the vapour given off by the preparation consumed by his followers at Surat having overpowered him, might in fact be cited as a commentary on the passage in Herodotus. O. Schrader, in fact, says the Scythians never washed in water but intoxicated themselves with the smoke of the seeds of hemp. In Persia the seeds are called *Shahdanah*, or Emperor's seeds. Tragus tells us that in Eastern France in his time (1539 A.D.) the seed was cooked daily among other foods such as barley, but he adds it was regarded as dangerous if partaken of too liberally or too frequently. Paludanus in a footnote to Linschoten's account of hemp refers (1598) to a mixture eaten in India called *bosa* or *boza* which, he says, consisted of the seeds of *Lolium* and of hemp (see **Eleusine**, p. 521; also **Malt Liquors**, p. 758). Mr. W. Coldstream, for example, informed the Commission that the edible preparation known as *múra* consists of hemp-seeds mixed with parched wheat or *bathu* (*Amarantus*) or of rice. Pundit Gunga Datt Upreti spoke of the seeds being cooked in Almora along with vegetables. Mr. Dharma Nand Joshi remarked that they make all vegetables palatable and wholesome. Mr. Anderson spoke of the parched hemp being mixed with grain and eaten, although, he adds, the mixture sometimes affects the eyes in the fashion known of *charas*. Mr. R. C. Artal of Bijapur mentioned that the seeds are employed as an ingredient in chutney. Mr. Minniken observed that in Bashahr the ripe seed is mixed with spirit to make it more intoxicating, and Sir Walter Lawrence in his work on Kashmir informs us that "the hemp seeds yield an oil which like *charras* is used for intoxicating purposes." It may thus be concluded that if the fruits be used without being specially cleaned they may be, and in India apparently often are, so impregnated or agglutinated with narcotic that they are distinctly intoxicating. These fully substantiated facts seem to justify the inference that the Scythians of old, as do the African bushmen to-day (Burton, *Arab. Nights*, i., 65), became intoxicated by inhaling the volatile narcotic present on the seed-coats and adhering particles of the inflorescence, without for centuries thereafter the drug having been isolated or separately recognised.

Hemp-seed is employed as a food for birds, poultry, etc., and in India is specially commended as an occasional diet for milch-cows.

Oil.

Soft Soap.

Yield.

Oil.—Hemp-seed when expressed yields 15 to 25 per cent. of a pale limpid oil. This is at first of a greenish-yellow colour but gradually deepens when exposed to the air. The flavour is described as disagreeable, but the odour as mild. Its sp. gr. ranges from 0·925 to 0·931. It becomes turbid at a temperature of 15° C. It absorbs from 143 to 144 per cent. of its own weight of iodine. Its drying properties are good, but in England it is rarely used for paint, though in some parts of Europe, where procurable in abundance (especially in Russia), it is fairly extensively utilised. It is also largely employed as a lamp oil, but its best use is in the preparation of soft soap. It dissolves in boiling water, and in 30 parts of cold alcohol. It is sometimes difficult to get linseed oil absolutely free from adulteration with hemp-seed oil. The oilcake is used in feeding stock. In the United States hemp is said to yield from 20 to 40 bushels of seed to the acre. The plant requires to be harvested before becoming quite ripe, owing to liability to seeding. The seed loses its germinating power very quickly, hence the stock should be one season old only. It is said that Russia annually produces close on half a million tons.

III. THE NARCOTIC—INDIAN HEMP.

So much has already been indicated of the narcotic property of Indian hemp that the subject need hardly be further dealt with in this work. Moreover, it has been so thoroughly treated of, in the publications quoted in the opening preamble, that it seems only necessary to refer the reader, who may desire full particulars, to these most useful publications. As already explained, there are primarily three forms of Indian hemp, with, under each, local modifications, special preparations, adulterants and imitations. Chemically, all three are one and the same. They represent different methods of production, different degrees of purity and intensity, and are often so blended into each other that their isolation becomes impossible, or nearly so. They may, however, be indicated briefly, as follows :—

Bhang.

Male Plant Inferior.

1. ***Bhang.***—This is also known as *siddhi*, *subji*, or *sabzi*, *thandai*, *patti*, etc., and in Central India it is *vijaya*, *buti*, and *sabzi*. It consists of the specially dried leaves and flowering shoots of either or both the male and female plants, whether wild or cultivated. Lt.-Col. Prain dissents somewhat from this opinion, since he would appear to believe that the male plant is inferior to the female in value as *bhang*. "There is reason for thinking," he says, "that from the best *bhang* male leaves are excluded." The narcotic principle, though not present in the very young state, begins to form with the growth of the plants, and reaches its greatest abundance about the time the flowers appear. But it gradually diminishes as the leaves pass maturity, and is entirely absent (or nearly so) from leaves allowed to turn yellow and to be dried up while still attached to the plant. [Baden-Powell, *Pb. Prod.*, i., 505; *H.D.C.R.*, iii., app., 153; Prain, *Cult. and Use of Ganja*, 12.]

Various Names.

Semi-cultivation.

Flavoured and Perfumed.

Poisoned.

Sweetmeat.

The dried leaves as met with in the Indian drug-shops usually consist of a powder known as *siddhi*, and this may be composed of fragmentary leaves only, or, as already stated, of the inflorescence as well, and even of the seeds. Sometimes this is called *patti* (the leaf), the word *bhang*, the most general of all, having more often a wider signification than the dried leaves. *Siddhi* is collected on the plains and lower hills, frequently from the wild plant, but here and there, all over the country, small plots may be seen near the homesteads in which the plant exists in the condition of semi-cultivation. When prepared for consumption the fragments of the plant are ground to a paste, and of this an emulsion is made which, after being filtered through a cloth, may be consumed in that form, or flavoured with sugar, spices, cardamoms, melon seeds or milk. The simple beverage goes by various names: *bhang* or *siddhi* in Bengal; *siddhi* or *thandai* in the United Provinces; *ghota* in the Central Provinces; and *ghota*, *tadhal* or *panga* in Sind. In Madras a similar liquid is called *ramras* or *ramrasam*, which in Upper India is sometimes called *dudhia*. In Poona a beer made with *juar* and *bhang* is called *bhoja*. Occasionally musk or other perfumes are added to disguise the objectionable smell, while to make the beverage more intoxicating and poisonous, opium, *dhatura* seeds, arsenic, strychnine, aconite, oleander root, and the seeds of black henbane are used. The special employment of the roots of certain grasses such as rice and *juár* is frequently resorted to (see **Sorghum vulgare**, p. 1040). A preparation of Indian hemp and alcohol is called *lutki*, and a drink called *mudra* (used in Baluchistan and the Panjáb) is said to contain hemp, opium, alcohol, and *dhatura*. *Majun* is a sweetmeat prepared from the emulsion; it is extensively eaten all over India. The Emperor Baber mentions in his *Memoirs* (1519) the number of times he had partaken of "*maajun*." John Lindsay (*Journ. Captivity in Mysore*, 1781, iii., 293) tells of his soldiers having been obliged to eat a "*majum*." The practice is, therefore, a fairly ancient one. Lastly, it may be pointed out that in Thomas de Quincey's *Confessions of an English Opium-eater*, "*madjoon*" would seem to be spoken of (but quite incorrectly) as the Turkish name for opium.

The Beverage of the People.

Of all the forms of Indian hemp *bhang* is the least harmful, and, according to the vast majority of the opinions recorded by the H.D. Commission, it is the beer or refreshing beverage—the occasional indulgences or luxury of the middle and better classes of India. A large percentage of the people use it, and apparently with less injurious consequences than the similar consumption of alcohol in Europe. It is not, however, a cheap beverage, since the flavouring and perfuming adjuncts are expensive. By the people in the localities where the plant is wild, however, it is often employed in the form of a simple infusion without any adjuncts, and then of course it may be had for the trouble of collection and preparation. It would seem satisfactorily proved that no form of Indian hemp possesses the property of establishing a craving for its continued and extended use. The total prohibition, even were that possible, would therefore be strongly opposed by the majority of the people, though the fiscal control established by the Government meets with their very general approval. Honigberger tells us that in his day, "not far from the outside of the Delhi gate at Lahore, near the road to Amritsar, close by my hospital, there was an establishment called Sed Gunge, where this beverage was delivered gratuitously." Several witnesses reported to the H.D. Commissioners places where the beverage was daily given (even now) to all applicants free of charge. Dr. Ewens alludes to the seats (*takiars*) in Lahore, where men assemble to drink *bhang*. Moreover, the use of *bhang* is considered essential in certain religious observances by a large section of the Indian community, and its total prohibition (sometimes recommended by Europeans) would be regarded as an encroachment on religious liberty. The employment of *bhang* as a cattle medicine is so widespread that its discontinuance would be resented even by those who do not consume it themselves as a beverage.

Prohibition Resented.

Given Free.

Charas.

Gelotophyllis.

Season of Formation.

2. ***Charas.***—This may be defined as a resinous substance that appears spontaneously on the leaves, stems, inflorescences and fruits of the hemp plant when cultivated in cold and dry countries. It is practically the active principle, and consequently a more powerful drug than either *bhang* or *ganja*. It is spoken of as the special narcotic procured throughout the North-West Himalaya from Nepal, Kumaon, Kashmir, Afghanistan, Ladakh, Herat, Bokhara to Turkestan, and was very possibly the *gelotophyllis* (laughing leaf) which Pliny says came from Bactriana. The resin appears shortly before the flowers begin to form, and is present over a larger proportion of the plant than is the case with the third form, *ganja*, presently to be described. According to most writers *charas* is not produced on the male plants, a circumstance probably due to their being removed on account of the fine fibres contained in their stems, before the time that the *charas* would naturally appear.

Becomes Inert.

Imported in Bags.

Adulteration.

Ancient Khotan.

Prain speaks of *charas* as a greenish-brown moist, resinous mass that possesses the peculiar odour of the hemp plant. When kept for some time it hardens, becomes friable and brownish-grey in colour, but when that earthy condition is fully attained, the drug is found to be inert. The name *charas* is said to mean a "bag" or "skin," and was given in India in allusion to "the bags" in which the drug is imported from Central Asia. The name *charas* would, therefore, point to this peculiar form of the drug having been originally recognised as foreign produce. In a commentary on the celebrated Sanskrit grammar written by Panini (300 B.C.), *tilakata*, *umakata* and *bhangakata* occur, and the termination *kata*, it is explained, means *rajas* or dust of sesamum, of linseed and of hemp. The *kata* of *bhanga* might have been at once viewed as the resinous powder now known as *charas* but for the difficulty of understanding what could have been the *kata* of the other plants—perhaps the pollen grains in all cases were therefore meant. In Turkestan (according to Aitchison) *charas* is called *nasha*, before it is made up into the skin packages ready for export to India. It is subsequently freely adulterated with linseed oil and a powder of the dried leaves of the plant. In passing it may be here pointed out that Stein (*Ancient Khotan*) makes no mention of coming across, in the ruins explored by him, either samples of *charas* or of the hemp plant in any form, and further that in neither *The Bower Manuscript* nor the voluminous records found by Stein is there apparently any mention of the hemp drugs. This is the more significant since, while discussing the modern trade in *charas*, Stein (*l.c.* footnote, 133) observes that the heavy import duty now imposed by the Government of India has caused the traders of Turkestan to turn to Khotan silk as a substitute commodity to be conveyed to India and there disposed of in exchange for the return of Indian goods.

Charas versus *Ganja.*

The line of separation between what should be called *charas* and what might be accepted as *ganja* is, however, a very narrow one indeed. It would seem highly probable, in fact, that on the moister southern slopes of the Himalaya the resinous substance produced by rubbing the fruiting panicles between the hands is more frequently *ganja* than *charas.* The definition that *charas* is the pure resin without any admixture of vegetable tissue is true no doubt, but is perhaps not the whole truth. If both articles were freed from foreign matter, the question might still have to be asked, In what respects do they differ? Physically more than chemically very possibly, and as the direct consequence of production in a cold-dry or warm-damp atmosphere. [*Cf.* Marshall, *Contrib. to Pharm. of Cannabis Ind.*, 1899; Holmes, *Mus. Rept. Pharm. Soc.*, 1903, 47.]

Kashmir *Ganja.*

Sir Walter Lawrence (*Valley of Kashmir*, 67) has expressed astonishment that the drug produced in Kashmir is in trade called *charas*, whereas "recent inquiries show that in the south of the valley the drug known as *gard bhang* or *churu charras*, is extracted from the female plant, and Indians who consume it declare that it is real *ganja* and utterly distinct from the Yarkandi *charras*, which is also procurable in Srinagar." "If the Kashmirí drug is *ganja* and not *charras* it is somewhat surprising, and I have taken some pains to verify the statement made by the official, who investigated the subject of hemp drugs. He and the men employed in the trade maintain that the drug made in Kashmir is *ganja*." Lawrence then adds that contrary to the experience in Bengal, Kashmir *ganja* is produced from plants that are allowed to mature seeds, the oil from which is also intoxicating. It is thus highly probable that the true *charas* is a foreign article exclusively derived from Central Asia, and, as it came to India through Kashmir, was in ancient times called Kashmiri. Formerly it came also *viâ* Nepal, but at the present day the chief emporium is Hoshiarpur, the supply coming both *viâ* Kashmir and Kullu. It would thus seem highly probable that we do not even now possess an accurate account of the production of this substance, nor all the information desirable of the condition under which the dry resin *charas* or the moist adhesive *ganja* is produced. Prain holds that the former being comparatively permanent once on the surface, it is not affected by the subsequent fecundation and development of seed.

Central Asia.

It may be here observed that there is at least one important difference between the South Himalayan so-called *charas* and that from Central Asia, namely the former is taken from the green plant before it is reaped, and the latter from the dried plant. The possibility of adulteration with actual dust and with fragments of the plant is very great with the Central Asiatic *charas*, and this circumstance may account for the higher price often paid for the purer qualities of the Indian so-called *charas.* For methods of collection consult the *Dictionary* (ii., 115–7); and Baden-Powell (*Pb. Prod.*, 1868, 293, etc.).

Charas is almost exclusively used in smoking, though some of the finer qualities are employed for medicinal purposes. It is admitted on all hands to be a more pernicious drug than either *bhang* or *ganja.*

Ganja.

3. **Ganja.**—This is the dried flowering tops of the cultivated female plants, which become coated with a resinous exudation from glandular hairs, very largely, it would seem, in consequence of being deprived of the opportunity of setting seed. To secure this result, therefore, the male plants are deliberately removed from the field at an early date, by an expert known as the *poddar.* (Compare this with the account above of the removal of the males from the fibre-yielding crop.) One or two visits are paid by the *poddar*, with the result that every male plant is uprooted. As the female plants begin to form *ganja*, all the large leaves on their

The *Poddar.*

Valuation.

stems and branches are also removed. The smaller leaves and bracts of the inflorescence become agglutinated and the manufactured article is valued very largely by its freedom from leaf. The colour and smell are features of merit, but as a rule the *ganja* which has the least leaf is regarded as the best.

Areas of Production.

Bengal Cultivation.

Ganja is cultivated in several localities such as in North Bengal, on the Malabar Coast of Western India, and in the Tributary Mahals of Orissa (the *Gurjat ganja*). These may be regarded as the chief centres, but it is also produced in the Central Provinces (Nimar), in Indore, Gwalior, Kishengarh, Mysore, Hyderabad, and in some districts of the Bombay Presidency. It may suffice to give a few practical facts regarding the Bengal cultivation and manufacture. It is grown in a very compact tract of country with a radius of about sixteen miles, and which lies in three districts, viz. Dinajpur, Rajshahi and Bogra. It is for administrative purposes placed under the Collector of Rajshahi, the sub-divisional officer of Naogaon being in immediate charge of this, the so-called *Ganja Mahal*. Seed-beds are formed on high land above inundation, and consist of a light sandy loam. The beds are richly manured and ploughed once a week from the middle of May forward, and are sown in August. Meantime the land on which the crop is to be ultimately raised is being also richly manured and top-dressed from the ditches and ploughed and harrowed once a month. By the middle of September the seedlings are transplanted to the ridges formed in the field. A month later a careful weeding is given, and in November the ridges are hoed down and the plants trimmed by the removal of the lower branches. This admits of a further ploughing between the furrows and of a top dressing with powdered cow-dung and oilcake, after which the ridges are again built up.

Abortive Female Flowers.

Poddar's Guide.

Harvest.

At this stage the first visit of the "*ganja* doctor"—the *poddar*—is made Prain, in his paper (*Morphol., Teratol., etc., l.c.*), explains that the *poddar's* guide is the early appearance "of the often abortive, solitary female flowers that so frequently, in the Indian male hemp plant, take the place that theoretically should be occupied by the lowest pairs of paniculate male inflorescences." These abnormally placed female flowers, it would seem, are visible long before the inflorescence of male flowers could for certain be recognised. The *poddar* in consequence breaks the stems of the plants that manifest this peculiarity and the cultivator following behind uproots them, and fills up the vacant places by fresh transplantations from the purposely reserved surplus in the seed-beds. A second or a third visit of the *poddar* suffices for the complete extirpation of the male plants. But abnormal male flowers are not unusual on the female plants, and these the cultivator keeps a sharp outlook for and removes. By January the flowers begin to appear, harvest is general in February, and by the middle of March is completed.

There are three forms of *ganja* produced:—

Flat.

(*a*) ***Flat Ganja.***—The stems are cut with a sickle about 6 inches above ground, tied together by their ends, placed across a bamboo and carried to the selected place of manufacture. The inflorescences are then one by one placed on the ground, and trodden underfoot so as to cause the agglutinated flower-tops and smaller leaves to become compacted into flat masses (*chápta ganja*). These heads are then baled as "large flat" or "twig flat," according to the size of heads and length of stalks.

Round.

(*b*) ***Round Ganja.***—Instead of being trodden, the heads are rolled underfoot so that they are less firmly compacted, and are in the form of rounded or sausage-shaped masses. Round *ganja* is never baled, but is tied up into bundles (*goli ganja*).

Powder.

(*c*) ***Chur (Powder) Ganja or Rora.***—Broken fragments or flower-tops detached from the twigs, whether of flat or round *ganja*, constitute *chur*. These are very largely produced through trimming, especially that of the round form.

Bengal Ganja is in other provinces of India usually designated as

"Baluchar," from the name of a village where it is supposed to have been originally procured. The *ganja* of Upper India, such as that of Gwalior and the Central Provinces, is called "Pathar." The refuse from the manufacture of *ganja* is often sold as *bhang*.

Insanity.

Medicinal and Chemical Properties.—The action of the drug in causing insanity has, by the Report of the Hemp Drugs Commission, been viewed as a greatly overstated belief. The moderate use of the drug is attended with no evil physical effects. If pure and taken in moderation it has little or no tendency to originate insanity. But when mixed with the poisonous substances sometimes employed it becomes most pernicious. Excessive use of hemp in any form, however, indicates and intensifies mental instability. It tends to weaken the mind, and may even lead to insanity. But in the year of the Hemp Drugs Commission only 7·3 per cent. of lunatics admitted to all the Asylums in India were said to be those in which hemp could reasonably be regarded as having been a factor of importance. [*Cf.* Gibbon, *Med. Jurisprudence for Ind.*; Walsh, in *Journ. Mental Science*, 1894.] Moreover, the insanity produced, as a rule readily gives way to treatment, and since the drug creates no craving its discontinuance is possible, and the restoration of the mental faculties almost instant. So much has, however, been written on these subjects that it is impossible to do more than refer the reader to some of the standard works that may with advantage be consulted.

Mental Instability.

Creates no Craving.

[Pereira, *Mat. Med.*, 1850, ii., 1237–44; Hamilton, *Fl. Homœop.*, 1852, i., 134–42; Honigberger, *Thirty-five Years in the East*, 1852, i., 153–7; ii., 248–56; Hem Chunder Kerr, *Rept. of Cult. and Trade in Ganja*, 1877; Fluckiger and Hanbury, *Pharmacog.*, 1879, 546; Dunstan and Henry, *Exam. of Active Principle of Hemp*, in *Journ. Soc. Chem. Indust.*, 1898, xvii.. 269; *Derivatives of Cannabinol*, in *Yearbook of Pharmacy*, 1899, 73; 1900, 133; Dutt, *Mat. Med. Hind.*, 1900, 235–41; *Pharm. Journ.*, 1902, lxviii., Holmes, 342; Marshall, 362; Humphrey, 392; Greenish, 492; lxix., Holmes, 129; Mahen, 131; 1903, lxxi., 431, 548; *Ind. Med. Gaz.*, Nov. 1904, 401–15, 421.]

Trade and Revenue.

Trade and Fiscal Administration.—In India the cultivation of this plant, where intended for the production of *ganja*, can alone be undertaken under license; moreover, the cultivation is periodically inspected, and the yield approximately ascertained. While no restrictions are placed on the sales to the trade, the produce when disposed of by the cultivator is stored either in Government warehouses for the purpose, or in approved godowns under double keys, one retained by the owner, the other by a Government official. Removals pay the fixed duty, and are recorded in such a way as to show the relation to the cultivator's estimated production and deed of sale. Both wholesale and retail traders have to obtain licenses. The traffic in *ganja* is thus under complete control through every stage. With regard to *charas*, a minimum duty of Rs. 80 per maund is levied on all imports. The drug is stored in approved warehouses and a further duty paid on removal, while inter-provincial adjustments are conducted on permits to carry from one province to another. *Bhang*, where found possible, is also taxed, but, the plant being wild in many localities, no interference is made with the domestic supplies of the people, the regulations having effect only on actual sales and regular trade. The sale of the narcotic in any form by persons not licensed to cultivate or sell these drugs, is a criminal offence.

License.

Stored.

Duty.

Criminal Offence.

Separate licenses have to be taken out for the traffic in each of the three kinds of the drug, and the retail vendor is prohibited from supplying children or insane persons with any. A limit is at the same time fixed on the amount that may be either sold to, or possessed by, a private person at one time. It is universally believed by both traders and consumers that all forms of the drug deteriorate with age. This is just the opposite opinion to that held with regard to opium. It accordingly follows that every effort is made to dispose of the produce year by year, and not to store it. It is perhaps on this account that such indifferent results have been obtained with Indian hemp as a medicine in Europe as compared with India. Long years ago Honigberger (*l.c.* 157) deplored this fact. To ensure fresh stuff it has accordingly been recommended by Prain that all purchases by the European dealers should be made direct through the Government official in joint charge of the warehouses.

Deterioration with Age.

Direct Purchase Recommended.

Area and Revenue.—In 1895, when the Government of India published their Resolution on the Report of the H.D. Commission, the total area in all India under regular cultivation of the plant was estimated at under 6,000 acres. In 1900–1 the *Agricultural Statistics of India* show the extent of cultivation to have been only 4,096 acres; in 1901–2 it would appear to have stood at 2,496 acres; in 1902–3 at 1,940 acres; in 1903–4 at 2,637 acres; and in 1905–6 at 2,645 acres, with, over and above, 419 acres in the Native States. If these figures denote an actual curtailment of area, not merely more accurate returns, they have curiously enough been coincident with increasing revenue. In the *Excise Administration Reports*, the Hemp Drugs are shown to have realised a total revenue of £201,344 in 1900–1, of £213,224 in 1901–2, and of £225,352 in 1902–3—later figures are not available. It would therefore seem that official returns may be accepted as exemplifying the continued careful control and restriction pursued by the Government.

Area.

Reduction in Area but Expansion of Revenue.

Prices and Duty.—The prices of the various forms of Indian hemp vary so greatly that it seems hardly worth while to give a quotation of the figures usually recorded. The price depends upon a multitude of circumstances, such as the quality, method of preparation, degree of taxation, and the like. The Government of India, in their Resolution on the H.D. Commissioners' Report, placed before the various Indian Administrations a table of retail prices per seer (2 lb.), which was commended to their attention with a view to gradually securing a greater uniformity. To manifest the extremes exhibited in that table the following may be abstracted:—GANJA in Assam sells at Rs. 15 lowest price and Rs. 40 highest price; while in Bombay it is sold, lowest price 6 annas and highest Rs. 5. CHARAS in Panjáb, lowest price Rs. 4, highest Rs. 15; while in Bengal its lowest price is Rs. 35 and its highest Rs. 40. BHANG in Panjáb sells at lowest price 2 annas and highest 8 annas, while in Bengal its lowest price is Rs. 1 and the highest Rs. 6 per seer. These variations to a large extent are the direct expression of the varying incidence of taxation, but there can be little or no doubt that there is a considerable variability in intrinsic merit, not only between the produce of one province and another but even between the different districts of the same province.

Prices: Duty.

Highest and Lowest.

Intrinsic Merit.

For the rates of duty and all other particulars regarding the traffic in hemp narcotics, the reader should consult the provincial Reports of Excise Administration in India. Some of these annual volumes (especially those published by the Government of Bengal) will be found to contain the fullest possible details.

D.E.P., ii., 133. Caper.

CAPPARIS SPINOSA, *Linn.; Fl. Br. Ind.*, i., 173; Cooke, *Fl. Pres. Bomb.*, i., 44; *Pharmacog. Ind.*, i., 135; CAPPARIDEÆ. The Edible Caper of Europe and the *kabarra, kaur, kiari*, etc., of India.

A small prostrate shrub found on hilly and rocky ground in Upper India. It is distributed to Afghanistan, West Asia, Europe, N. Africa, Australia and the Sandwich Islands. There are a considerable number of species of ***Capparis***, no less than 30 being mentioned in the *Flora of British India*, but only two or three besides ***C. spinosa*** are of any great importance. These are ***C. aphylla***, *Roth.*, the *karél, nepti*, etc.—a dense much-branched shrub found abundantly in the drier parts of the Panjáb, Gujarat, Rajputana, Deccan and S. Karnátak, and ***C. horrida***, *Linn., f.*, the *ardanda, karvíla*, etc., found in the Gangetic valley, etc., as far north as Saharanpur, in the Western Peninsula, also in Chittagong, Pegu and Ceylon. It is also distributed to Java and the Philippines. Besides these ***C. grandis***, the *pachunda, guli*, etc., is found in the Deccan, Karnátak and Ceylon.

Oils. Several species are known to yield OILS. ***C. grandis*** affords an oil used in medicine and for burning, while ***C. spinosa*** yields a volatile oil which has the properties of garlic oil (*Pharmacog. Ind., l.c.*). The caper is mentioned by Greek and Latin writers, and through them doubtless the MEDICINAL properties of the root were made known to the Arabs. It was very generally employed in affections of the liver and spleen, and also in amenorrhœa. In India all parts of the plant are regarded as stimulating and astringent, when externally applied. The young flower-buds and fruits of ***C. aphylla***, as also of ***C. spinosa***, are eaten in India. The former species is the more important; the buds are pickled and the fruits eaten both when green and when fully ripe. ***C. spinosa*** is met with in the Panjáb, but it has never assumed the position of importance assigned to it in Europe, where the pickled buds form the "Capers" of commerce. Gerarde (1596) and Miller (1748) mention that the caper had been successfully grown in England in the open air, but it is usually regarded as requiring protection in winter. The WOOD of ***C. aphylla*** is employed in India for making combs, small beams and rafters, for the knees of boats, etc., and is valuable because of its not being attacked by white ants. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 120.]

Medicine.

Food.

Timber.

D.E.P., ii., 134-40. Red Pepper.

CAPSICUM, *Linn.: Fl. Br. Ind.*, iv., 238; Steph. and Church., *Med. Bot.*, 1834, i., pl. 44; Bentley and Trimen, *Med. Pl.*, t. 189; Duthie and Fuller, *Field and Garden Crops*, iii., 36–7, pl. 72, 74; Sturtevant, *Hist. Gard. Veg.*, in *Amer. Nat.*, 1890, xxiv., 151–7; Irish, *Rev. Genus Capsicum*, in *Missouri Bot. Gard.*, 1898, ix., 53–110, tt. 8–28; SOLANACEÆ. The Guinea Pepper, Red Pepper, Pod Pepper, Chilli, Cayenne, Tabasco, etc.

History. **History.**—There would seem to be little doubt that the entire series of plants constituting the genus ***Capsicum*** are natives of tropical America. Peter Martyr was perhaps the first person who described this kind of pepper. In an epistle dated 1493 (the year following the discovery of the West Indies), he says that Columbus had brought to Spain "pepper more pungent than that from the Caucasus." In 1494 Chanca, the physician who accompanied Columbus on his second voyage, addressed a letter to the Chapter of Seville on the same subject. In that he calls this pepper by its West Indian name, *axi*—a word that has since been rendered as *achi* or *agi*, and has survived in Spanish to this day. Although some of the 16th century authors maintain that the *siliquastrum* of Pliny is the Pod Pepper (***Capsicum***) of modern trade, the more strictly botanical writers are very nearly unanimous in the opinion that capsicum was not known in Europe prior to the discovery of America. In passing it may further be observed that all the older authors speak of *siliquastrum* as coming from Calicut, from which circumstance it may be inferred to have been the cardamom—a spice which to this day is almost exclusively derived from that port and which has been associated with the Malabar Coast of India from the remotest antiquity. At all events Amatus on Dioscorides (pub. 1554) distinctly confuses capsicum with cardamom. Fuchs (*Comment. de l'Hist. des Pl.*, 1542–9, ch. 281; also *Hist. Stirp.*, 1555, 797) gives an account of "Siliquastro or Piperitis," which by some is called "Indian or Chalechut Pepper," "Cardamom," "Spanish Pepper," etc., and which Avicenna speaks of under the name of "Zingiber caninum."

Columbus.

Cardamom confused with Capsicum.

Brought from Goa.

Pernambuco Pepper.

Early Indian Pictures.

Matthiolus (*New Kreüterb.*, 1563, 216) gives a good plate of **Capsicum** and calls it "Calicut pepper." He says it is a foreign plant lately introduced into gardens in Germany, and subsequently (*Med. Compend.*, 1571, 322) he remarks that it is an obvious mistake to confuse **Capsicum** with **Cardamomum**. Lobel (*Stirp. Adv. Nova,* 1570, 134) observes that within his memory this plant (of which he gives a good plate) has been brought from Goa and the shores of Calicut. There can be no doubt, therefore, that the Portuguese had very early introduced Capsicum into Goa, and very possibly commenced to export it, in competition with the true pepper, hence Lobel as an after-thought may have associated Calicut with the new emporium Goa. Clusius (review of Garcia de Orta) in the *Aromaticum,* published in 1574, makes no mention of **Capsicum**, so that it may be inferred the plant had not been seen by Garcia de Orta in India. A little later, however, Clusius (*Hist. Exot. Pl.*, 1605, 340) under *Capsicum brazilianum* or wild pepper, observes that Spanish or American pepper was brought from the Spanish West Indies and carried to India by the Portuguese under the name of Pernambuco Pepper. Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri re Nat. et Med.*, 1658, 130–1), who wrote in 1629, describes this pepper under the names of *Lada Chili* and Brazilian *Ricinus*, a fact that led some authors to confuse it with **Ricinus communis**—the Castor Oil. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 171.] Rheede (*Hort. Mal.*, 1679, ii., 109, pl. 56, in a note by John Commelin) remarks that the *capo-molago* or Indian pepper described by him was in reality Brazilian pepper, the prefix *capo* or *capro* denoting its introduction by the Arab traders; his plate is a typical example of **Capsicum frutescens**. It is practically the same plant which Rochefort calls *axi* or *carive*; which Recchus (*Nat. Hist. New Spain*) describes as *chilli* or Mexican pepper; possibly also that which Piso calls by its Brazilian name *quiya*; which Elizabeth Blackwell figures and describes in her *Curious Herbal* (1739, i., pl. 161); and which Hernandius (*Hist. Pl. Nov. Hisp.*, 1790, i., 277–82) discusses and illustrates most fully as one of the forms of **Capsicum**. In a further passage Rheede gives a plate of the *vallai-capo-molago,* which is doubtless *var.* **grossa**, and was thus apparently a more recent introduction into India than the *capo-molago.* [*Cf.* Labat, *Nouv. Voy. aux Isles de l'Amerique,* 1724, ii., 68; Milburn, *Or. Comm.*, ii., 208; Bentham, *Notes on Targioni-Tozzetti, Cult. Pl.*, in *Journ. Hort. Soc.*, 1855, ix., 141; Henry, *Econ. Bot. China,* 39; Semler, *Trop. Agrik.*, 1900, ii., 284–5; *Pharm. Soc. Mus. Repts.*, 1895–1902, 58.]

Rheede *versus* Rumphius.

Gracia de Orta and Marco Polo.

Modern Names.

With a history so full and so pertinent (many other authors might be cited), it is indeed surprising that one of the greatest of Eastern botanical authors, nearly a hundred years after the appearance of Rheede's *Hortus Malabaricus,* should have affirmed in the most emphatic manner possible his belief that at least certain forms of **Capsicum** had not only been cultivated in India from the most ancient times, but that it was the *siliquastrum* of Pliny and *Capsicum orientale* of Actuarius. Rumphius (*Herb. Amb.*, 1750, v., 247–52, pl. 88, ff. 1–4) advanced those opinions without observing that many of the passages in his own most admirable and detailed account contradicted his main contention. For example, while commenting on Rheede's Malabar name *molago,* he deprecatingly observes that no mention is made of its daily and well-known use as a condiment. It never seems to have occurred to Rumphius that Rheede's silence on that point, as also the fact that Marco Polo (1286–96) and Garcia de Orta (1563) made no reference at all to capsicum (though they discuss ordinary pepper and the cardamom), might be accounted for by the belief that the capsicums were unknown to the Natives of India in the time of Marco Polo, and even so late as that of Garcia de Orta, while they were but imperfectly understood in Rheede's time. Rumphius describes three main forms of **Capsicum**, which he calls (*a*) the great red capsicum, the *ritsje* of the Dutch and *recche* of the Portuguese in India, the *tschili besar* or *tschili-ayer* of the Natives; (*b*) the lesser red capsicum—a fruticose plant called *tschili-mera*; and (*c*) the yellow **Capsicum** known as *tschili-cuning.* Rumphius then adds that the Portuguese write the West Indian name *axi* as *achi,* hence comes the Indian name *achar,* which the Dutch render *atsjar*—a word which has the same meaning as *reccheado,* namely pickles. It will thus be seen that practically the entire series of vernacular names mentioned by Rumphius, far from their establishing an ancient knowledge in India, would seem to prove that the introduction of the plant may have taken place somewhere about the middle of the 17th century. The names in use in India to-day are clearly of foreign or modern origin, such as *chillies, lal-marcha* (= red pepper), *goa-mircha* and the like. There are, in fact, no ancient names for the capsicums in Chinese, Sanskrit, Arabic, Persian, Hebrew, Greek, or Latin. No Indian botanist has ever recorded having found a species of ***Capsicum*** in a wild condition. But the rapidity with which the species and races of this pepper became disseminated throughout the tropical and warm temperate tracts of the globe, following closely on the discovery of the West Indies and America, is one of the many examples of the marvellous powers of adaptability and endurance possessed by the plant-cohorts from the New World on their invading the Old.

Varieties and Cultivated Forms.

C. annuum, *Linn.; C. grossum, Willd.*, in *Fl. Br. Ind.*, iv., 239; Irish, *l.c.* 65-97, tt. 10-28.

The following statement is derived mainly from Mr. H. C. Irish's admirable review of the varieties and cultivated races of this species:—

(*a*) **Var. abbreviatum,** *Fingerh.*: the Celestial, Etna, Kaleidoscope, Red Wrinkled Princess of Wales, etc.

Nepal Chilli.

(*b*) **Var. acuminatum,** *Fingerh.*: the best examples are the erect-fruited Chilli and the pendent-fruited Long Cayenne, Long Yellow Cayenne, Nepal Chilli and the Yellow Nepal Chilli. It includes, in fact, most if not all the long, pointed, pendent forms common as field crops. Recently Mr. H. M. Leake performed some interesting experiments with capsicums at Dalsing Sarai. He selected seed carefully and sowed them in order to watch the tendencies to variation. Nearly half the erect podded stock had pendent pods. Every plant was, however, consistent, either having all its pods erect or all suspended. He further found that chillies will grow on *usar* land if sown early. Very possibly most of Leake's plants belonged to this variety, but as I have not seen any of his specimens I cannot say for certain.

Influence of Soil.

This would appear to be the *Capsicum minus flavum* of Rumphius (*l.c.* 248). Mr. Irish remarks that the seed of the Nepal Chilli had been supplied by the Superintendent of Saharanpur Botanic Gardens, and on being cultivated proved different from other plants seen by him. In the *Report of the Saharanpur Botanic Gardens* (1894–5, 10) it is stated that the Superintendent had received seed direct from Col. H. Wylie, British Resident in Nepal. The plants grow freely, but the pods produced possessed none of the peculiar flavour and pungency of the pods imported from Nepal. The Superintendent then adds, "In the letter which accompanied the seeds Col. Wylie informed me that that would prove to be the case, as the variety so much in request is the product of a peculiar kind of soil, only found in certain localities, and that in Nepal itself the true Nepal chilli when not grown on the right soil, scarcely differs from the common long red chilli of Indian bazars."

Cherry Pepper.

(*c*) **Var. cerasiforme,** *Miller: Roxb., Fl. Ind.*, i., 574.—Cherry-pepper is often alluded to by the early authors, such as Miller, Gerarde, Parkinson, Tournefort, etc. This includes the Little Gem, Prince of Wales, Cherry, Yellow Cherry Oxheart, Yellow Oxheart, etc.

Cayenne.

(*d*) **Var. conoides,** *Miller*: the best-known races are the Coral Gem, Tobasco, Cayenne, Orange-Red Cluster, etc.

(*e*) **Var. fasciculatum,** *Sturt.*: the better known races are Red Cluster, Yellow Cluster, etc.

(*f*) **Var. grossum,** *Sendt.: Roxb., l.c.*—This is the *kaffree-murich*; is often alluded to and figured by the early European writers such as Miller, Parkinson, Fousch, Gregorius, Bauhin, Morison, Rheede, etc. Under this form have to be placed —The Emperor, Monstrous, Sweet Spanish, Bell, Ruby King, Golden King, Brazilian Upright, Squash, Yellow Squash. In India the races of this variety may be said to exist mainly as garden plants, though large inflated yellow fruits of this form have recently begun to appear in the markets as a regular article of trade.

Black Nubian.

(*g*) **Var. longum,** *Sendt.: C. annuum* and *purpureum, Roxb., Fl. Ind.*, i., 573; *C. bicolor, Bot. Mag.*, 43, n. 1835.—This is the plant most frequently described by the early European authors. The best-known races are Black Nubian, Long Red, Country Fair, Cardinal, Long Yellow, Elephant's Trunk, Ivory Trunk, etc. Roxburgh tells us that he found a single plant of ***C. purpureum*** in the Botanic Gardens, Calcutta, in 1796 but could not learn whence it came, though he adds, "most likely from the Malacca Islands." Irish assorts all these together as forms in which the calyx rarely embraces the base of the fruit. It seems probable that most of the plants hitherto regarded by writers on Indian garden plants as forms of ***C. frutescens*** should be relegated to this position

Bird Pepper.

C. frutescens, *Linn.; C. fastigiatum, Bl.;* Wight, *Illust. Ind. Bot.*, ii., 198; Dunal, in DC., *Prod.*, xiii., pt. i., 416; *C. minimum, Miller, Gard. Dict.*, 1768 (ed. viii.); Roxb., *Fl. Ind.*, i., 574; *Capo-Molago, Rheede, l.c.*

This is often called "Bird Pepper." According to the *Pharmacographia Indica* (ii., 563), *C. minimum* exists as a weed of cultivation in most parts of India. This I personally have never observed, and hesitate to accept. Owing to the large size of the plant it is the *gach-marich* of most Indian writers.

Var. baccatum, *Linn.: C. minus rubrum, Rumph., l.c.* 248, t. 88, f. 2; *C. Brasilianum, Clusius, Hist. Exot. Pl.*, 340, etc.

Evidences of Modern Origins.

Rheede and Rumphius figure and describe forms of *C. frutescens,* but say remarkably little about the capsicums most prevalently cultivated at the present day. And a thoughtful perusal of the passages used by Roxburgh, in his *Flora of India*, leaves the impression that, even in his day, the cultivation of no capsicum assumed the magnitude of a regular field crop, such as may be seen to-day in almost every province of India, especially in Bengal, Orissa, Madras and the Deccan. But *C. frutescens,* far from having become the most abundant form, is usually met with as solitary plants in the grounds around temples and in the flower gardens of the well-to-do classes, but is hardly if ever a regular crop. It is nearly always distinguished as the *gach-marich* or "*long ka morich,*" as it is called by Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 187–8). In India the most extensively cultivated are the following forms of *C. annuum:—var. acuminata* followed by *longa,* and next *cerasiformis.*

Field Crop.

Cultivation.
Bengal.

Cultivation.—It is impossible to furnish any statistics of the areas under these plants since they are most frequently raised as borders to fields, or as lines through fields. In Eastern and Northern Bengal, however, capsicum becomes a regular field crop, thriving best on a light sandy loam. The form most frequently seen is a long, narrow, pointed, pendulous red fruit. The seed is sown broadcast, and in Bogra, for example, capsicum assumes the condition of an exceedingly important cold-season crop. In the *Settlement Report for Nagpur, Central Provinces*, some useful particulars are afforded regarding chillies. The seed is sown about June and the seedlings are transplanted about August. In September the earth has to be banked up against the stems. Irrigation is necessary during the cold weather, and the crop comes into season from January to March. Its value is from Rs. 120 to Rs. 150 per acre. Dry chillies are only about one quarter the weight when green. Very little information exists regarding the red pepper of Assam or of Burma. Of the Kyaukse district of the latter province we read that the lowest estimated yield would be 365 lb. (=100 viss), valued at Rs. 15 an acre, the highest about Rs. 350. Of Sagaing it is said the seed is sown in August, planted out in September and October and the crop ripens from January to March, the green fruit a month earlier. A long and highly instructive account will be found in the *Settlement Report for Meiktila* (1896–8, 8, 23, 69), which shows the high-class cultivation pursued, the labour entailed, and the risks through failure of rains. The crop usually comes into bearing by the middle of December. The trade is entirely in the hands of the Chinese, who rule the market and export all they can purchase. In Myingyan the sowings are not made till September, and the plants come into season about March. Chillies have been recommended as a catch crop among young tea for Assam.

C. Prov.

Burma.

Bombay. In the Bombay Presidency chillies are rotated with ordinary market-garden produce. On the black soil of the Deccan (Krishna Valley) is produced a fairly large proportion of the red pepper conveyed to Bombay. But the most important areas of production in Western India are Dharwar, Belgaum, Khandesh, Satara, Poona and Sholapur. Capsicums are usually sown in the rains, but if the land be irrigated they become a *rabi* crop. Usually they are raised in a nursery and transplanted, and in about three months the first crop may be gathered. [*Cf.* Mollison, **Panjáb.** *Textbook Ind. Agri.*, 1901, iii., 206–9.] Speaking of the Panjáb, Dr. Stewart tells us that when grown on the hills, chillies become more pungent, hence no doubt the special merit of the so-called Nepal Cayenne. In the *Lahore Gazetteer* (1893–4, 164) will be found useful particulars of this crop. It is planted out in June and begins to come into season by October. Thirty maunds an acre for wet and 8 for dry are considered a fair outturn. The cultivators sell it wet at 30 seers or one maund the rupee. In the *Gazetteer for Montgomery District* (1898–9, 142) it is stated that the crop is sown in January–February; the ground dug about the roots in February–March; watered every fifteen days; and the pods collected May, June and July. White ants and parrots prey on it.

Food. ***Uses.***—It is needless to mention the varied uses of capsicum. The dried fruit reduced to powder forms the Red Pepper or Cayenne of com- **Cayenne Pepper.** merce. But cayenne is, as a rule, prepared from the small, very pungent fruited forms only. It is an ingredient in all curries and many other food preparations, and is used throughout India and by every class of the community, so that while of comparatively modern introduction, the consumption of red pepper has now become all but universal. There are various brands of pepper sauce, which are produced as decoctions of the **Vinegar.** fruits in salt water or vinegar (see p. 1110). Tabasco and Paprika are special European sauces. In Bengal an extract of the consistence of treacle is regularly prepared and sold. The green fruits are pickled or cooked fresh **Medicine.** with special dishes or even eaten raw. As a MEDICINE capsicum is stomachic, stimulant and astringent; cayenne pepper is a valued adjunct to gargles, and an ingredient in most medicines that are intended to alleviate toothache. As a rubefacient and counter-irritant, the bruised fruits, in the form of a poultice, act energetically, and added to mustard are often highly beneficial. For the medicinal uses and chemical properties the reader should consult the *Pharmacographia Indica* and other such works.

Trade. ***Trade in Capsicum.***—During the five years ending 1900–1 the foreign exports rose from 8,126,175 lb. valued at Rs. 7,20,925, to 9,485,820 lb. valued at Rs. 12,47,349. These figures represent an increase of 16·7 per cent. on the quantity, and as much as 73·0 per cent. on the value. In 1906–7 the corresponding figures were 11,007,929 lb. and Rs. 14,37,635. During that year Madras contributed 7,677,763 lb., Burma 1,386,739 lb., Bengal 1,567,162 lb., and Bombay 363,060 lb. The most important receiving countries were Ceylon, which took 8,419,713 lb., the Straits Settlements 1,872,738 lb., Mauritius 287,027 lb., Aden 104,356 lb., the United Kingdom 85,428 lb., and other countries the balance of the total.

These figures are, therefore, representative of the normal and present condition of the traffic, and they also denote its thriving condition. This is confirmed by the account of the *Trade carried by Rail and River in India* during 1906–7. During the five years previous the recorded transactions under the statement of imports were 832,648 cwt. in 1902–3; 760,611 cwt. in 1903–4; 763,106 cwt. in 1904–5; 977,801 cwt. in 1905–6; and 883,059 cwt. in 1906–7. But of these very large amounts only about one-third was received by the port towns as the supplies to meet local demands and foreign exports. Turning to the corresponding returns for exports, it is seen that Madras is by far the largest producing province of India proper (that is, excluding Burma, not shown in the returns of rail and river traffic), followed ordinarily by Bengal and the Panjáb. All the rest of India (including the Native States) exports usually about the same amount as Bengal, which is commonly only about half that of Madras.

CAREYA ARBOREA, *Roxb.*: *Fl. Br. Ind.*, ii., 511; Gamble, *Man. Ind. Timbs.*, 364; Cooke, *Fl. Pres. Bomb.*, i., 497; Duthie, *Fl. Upper Gang. Plain*, 344–5; Brandis, *Ind. Trees*, 332; MYRTACEÆ. The *kumbi, ayma, arjama, putai-tanni-maram, kumbir, buda-durmi, kaval, gavuldu, banbwe*, etc.

D.E.P., ii., 157.

A large deciduous tree of rapid growth, frequent in the Sub-Himalayan tracts from the Jumna eastward and in Bengal, Burma, Central, South and West India, ascending to 5,000 feet, also met with in the moist regions of Ceylon. Robinson (*Desc. Acc. Assam*, 1841, 43) described it as a "tree of immense size. The wood . . . well adapted for the stocks of match-locks." It is much subject to the defoliating *lymantriid* moth, ***Dasychira thwaitesii***, *Moore*. The leaves turn red in the cold season.

Gum and Fibre.

Tan and Dye

Medicine.

Food and Fodder.

Timber.

It appears to yield a GUM, and a good FIBRE for coarse cordage and sacks is made from the bark, the latter part being also employed in TANNING and as a DYE. Tasar silkworms feed on the leaves. The bark is also used as an astringent MEDICINE; when moistened it gives out much mucilage and is utilised in the preparation of emollient embrocations. The flowers are given as a tonic after child-birth, and the dried calyces (*vákumbhá*) of the flowers are sold in the market as a demulcent in coughs and colds. The fruit, known as *khúni*, is eaten in the Panjáb and is also given to cattle. According to Innes (*Jungle Products*, 1898, 10) the bark is ground into a kind of flour in Oudh during famine. The seeds are said to be more or less poisonous. The TIMBER, which is very durable and fairly hard, is used for agricultural implements, gunstocks, houseposts, cabinet-work, etc., but Kurz says it is too heavy for such purposes (43 to 60 lb. per cubic ft.). It stands well under water, and is much admired for axles. "This is an important tree with a fine wood, which is too much neglected" (Gamble). The fibrous bark is used as a slow-match in Mysore, and has been successfully tried by the Ordnance Department as a substitute for English beech in fuses. In Ganjam it serves for the scanty clothing of Hindus affecting sanctity. Rheede (*Hort. Mal.*, iii., 36) says that wild pigs are very fond of the bark, and that it is used by hunters to attract them.

CARICA PAPAYA, *Linn.*: *Fl. Br. Ind.*, ii., 599; Cooke, *Fl. Pres. Bomb.*, i., 524; PASSIFLOREÆ. Most of the vernacular names, *papeya, papaya, papia, bappayi, popai*, etc., are obviously derived from the Carib *ababai*, which is still further corrupted into the English Papaw. The Burmese name *himbawthi* means fruit brought by sea-going vessels, and the Panjábi name *kharbuza* is Castor-oil-Melon.

D.E.P., ii., 158.

Castor-oil-Melon.

History.

History.—A subherbaceous almost branchless tree, commonly cultivated in gardens throughout India and in various localities more or less naturalised. The fruit is not mentioned in the *Ain-i-Akbari* as having been known to Akbar. It was sent to Clusius from Brazil in 1611 (*Hist. Exot. Pl.*, app. 42), who gives good drawings of the male and female plants. George Marcgraf (*Hist. Pl.*, in Piso, *De Med. Bras.*, 1648, 103) furnishes an account of the plant, and a short description, with a figure, is given by Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 96). It was figured and described admirably by Boym in 1656 as an Indian plant introduced into China (*Fl. Sin.*, pl. A), so that it must be regarded as another instance of the rapid dispersion of new plants after the discovery of America. Rheede (*Hort. Mal.*, i., 21, f. 15), 1686, and Rumphius (*Herb. Amb.*, i., t. 50), 1750, also figure and describe both male and female plants, the former observing that the Malabar

Pharmacopœia did not include the drug. Hughes (*Hist. Barbados*, 1750, 181, tt. 14, 15) gives a couple of splendid plates prepared by Ehret, while Labat (*Nouv. Voy. aux Isles de l'Ameriq.*, 1724, ii., 308) contributes a useful account of the plant.

Medicine.

Active Principle.

Dr. Dymock believes that a fibre from the stem is utilised in America and Africa, but the principal value of the tree lies in the fruit, which is both eaten and employed as a MEDICINE. An account of its medicinal properties may here be summarised from *The Agricultural Ledger* (1896, No. 31). The digestive action of the juice upon meat was probably known in the West Indies at a very early date, and appears to have been communicated to the inhabitants of this country upon the introduction of the tree by the Portuguese. It has long been the custom in India to render meat tender by rubbing it with the juice of the fruit or by wrapping it in papaw leaves. In 1877 the milky juice began to attract attention in Europe as a digestive ferment, and Herr Wittmack of Berlin in 1878 made a careful examination of its properties (*Pharm. Journ.*, Nov. 30, 1878). On the evidence of medical, physiological and chemical experiments made with *papaya*, the active principle has been separated and given the name of *papain* or *papayotin*. It was first separated by Peckolt. This may now be considered almost an article of medical commerce in Europe, and has in fact been extensively used in France and Germany, as well as in England, being given with good results even to children. Notwithstanding all the experiments made with this vegetable pepsin, it has not as yet been introduced into the British Pharmacopœia, though four preparations of it are given in the "*Extra-Pharmacopœia*." *Papain* is even held by some to compare very unfavourably with pepsin when tested with egg albumen. Mr. J. C. Umney, reporting on a sample of 12 oz. of dried *Carica* powder, wrote:—"There is no doubt that by repeated precipitation by alcohol a highly active digestive product might be obtained from this crude concentrated *papaw* juice, valuable for use under those circumstances where pepsin is unavailable." [*Cf. Agri. Ledg., l.c.* 310; Bouchut and Wurtz, *Comptes Rendus*, 1889, 425; 1890, 1379; Bouchut, 617; Wurtz, 1891, 787; also *Dict. de Chem.*, suppl., ii; *Pharm. Journ.*, ser. 3, x., 343, 383; *Chem. and Drugg.*, 1904, 185.]

Collection.

Animal Pepsin.

A question of importance to be settled is the most serviceable form of commercial *papain*. And since prolonged moisture is deleterious, the juice should be dried as soon as possible; but heat is said to destroy its activity, hence it should be dried at a low temperature. A preparation of this kind is sold in commerce under the name of "Finkler's Papain." The best method to prepare *papain* is to collect the juice of the unripe fruit, mix it with twice its own volume of rectified spirit, let the mixture stand for a few hours, and then filter off the insoluble matter and dry *in vacuo* or over calcium chloride at the ordinary temperature of the atmosphere. After being powdered it should be kept in well-stoppered bottles ready for use. In view of a possible trade either in India or in Europe, manufacturers are recommended to observe carefully the precautions just enumerated. On account of caste difficulties, it might not prove possible to introduce animal pepsin very largely into use in India, but a good vegetable substitute might be of much value and find a ready sale.

Food.

Industrial Use.

The ripe FRUIT is eaten by all classes and esteemed innocent and wholesome. A wonderful range in quality is observable. In some localities, such as Hazaribagh in Chota Nagpur and Gauhatti in Assam, the fruit is large and very sweet; in others it is small, coarse and hardly edible. The opinion generally prevails that to obtain good fruit it is necessary to remove the majority of the male trees. The better qualities of the ripe fruit are eaten with a little sugar and fresh lemon juice, and by some people with pepper and salt. The use of *papaw* juice in softening tasar cocoons and thus facilitating their being reeled, has recently received some attention.

[*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 166, 196; Fleming, *Ind. Med. Pl. and Drugs*, in *As. Res.*, 1810, xi., 161–2; Ball, *Comment. Garcia de Orta, Coll.*, xxxvi., in *Roy. Ir. Acad.*, ser. 3, i., 653; *Pharmacog. Ind.*, ii., 53; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 790; *Der Tropenpflanzer*, 1901, v., 27, 288; viii., 94–5; Sly, *Papain or Veget. Pepsin*, in *Agri. Journ. Ind.*, 1907, ii., pt. 2, 212–3.]

D.E.P., ii., 165.

Bengal Currant.

CARISSA CARANDAS, *Linn.*: *Fl. Br. Ind.*, iii., 630; Buch.-Ham., *Stat. Acc. Dinaj.*, 169; Gamble, *Man. Ind. Timbs.*, 479; Cooke, *Fl. Pres. Bomb.*, ii., 124; APOCYNACEÆ. Bengal Currants (Mason), *karaundá, timukhia, kurumia, kalaka, kalivi, karekai, kan*, etc.

A dichotomously branched bush cultivated for its fruit in most parts of India and said to be wild in Oudh, Bengal, S. India, the Konkan and Kanara; distributed to Burma and Ceylon. The tree yields LAC in the Panjáb (*Agri. Ledg.*, 1901, No. 9, 211). The fruit is ripe in July to August. It is mentioned in the *Ain-i-Akbari* (Blochmann, transl., 1590, i., 67) as sub-acid, and as sold at 1 *dám* per seer, *i.e.* 40 seers for Rs. 1. It is said to be used as an AUXILIARY in DYEING and TANNING; an adhesive fluid exudes from wounds on the stem. When unripe the fruit is astringent, and when ripe cooling, acid and useful in bilious complaints and as an antiscorbutic. The root is acrid and is made up as a paste with lime-juice and camphor, and used to keep off flies and relieve itch. Just before it ripens the fruit is made into pickles and also employed in tarts and puddings. When fully ripe it makes a jelly equal to red currant, for which purpose it is grown in European gardens. The Natives universally eat it fresh and do not cook it, except as a preserve in curry or chutney. The TIMBER is hard, smooth and close-grained, and is used both as fuel and for making spoons and combs, especially at Udayagiri in Nellore. The shrub makes exceedingly strong fences, and its number of sharp spreading thorns render such hedges almost impassable.

Lac.

Seasons.

Dyeing and Tanning.

Medicine.

Food.

Timber.

C. spinarum, *A. DC.*; a small thorny evergreen shrub, wild in most parts of India, especially in the drier zones. The small fruit is eaten and the timber used for much the same purposes as that of ***C. Carandas.*** It is an important element in reafforestation, since it persists on the poorest and rockiest soils in spite of being greedily eaten by sheep and goats. Rumphius (*Herb. Amb.* (*Auctuar.*), 1755, vii., 57) describes ***C. Carandas***, the cultivated plant, whose fruits he says are made into pickles when half ripe. His plate (t. xxv.) is, however, such that its determination is impossible.

[*Cf.* Baber, *Memoirs*, 1519 (Engl. transl.), 326; J. Bauhin, *Hist. Pl.*, 1651, i., 88; Garcia de Orta, 1563, *Coll.*, xiii.; also in Clusius, *Arom. Hist.*, 1567, 214; and Ball, Comment. in *Proc. Roy. Ir. Acad.*, ser. 3, i., 400; Jones, *As. Res.*, iv., 263–5; *Pharmacog. Ind.*, ii., 419.]

CARPETS AND RUGS.—Birdwood, *Indust. Arts Ind.*, 370–86; Baden-Powell, *Handbook, Manuf. and Arts Pb.*, 1872, 10–2, 26–7, 51; W. P. Dickson, *Notes on Carpet Manuf. in Lahore Jail*, Dec. 1885; T. N. Mukharji, *Art Manuf. Ind.*, 388–98; *Monographs, Woollen Industries*:—N. Banerjei, *Bengal*, 1899, 15; A. W. Pim, *N.W. Prov.*, 1898, 9–12; D. C. Johnstone, *Panjáb*, 1886, 7–8; B. A. Brendon, *Bombay*, 1899, 7–12; J. T. Marten, *Cent. Prov.*, 1899, 8; E. Thurston, *Madras*, 1898, 1–11; *Journ. Ind. Art*, 1905, ix.; C. Latimer, *Monog. Carpet Making in Pb.*, 1907; Watt, *Ind. Art at Delhi*, 1903, 425–47. For MATS of vegetable fibres see under **Mats and Matting**, p. 775.

D.E.P., ii., 176–82. Carpets.

Pile Stitch and Plain Stitch.

History.—Considerations of space forbid any attempt to discuss the Carpet Industry of India in detail. As pointing possibly to their essentially foreign nature, carpets are in India often designated as *alcatifs* (*katif* = a carpet with long pile, in Arabic). They are mentioned by Pinto (1540 A.D.); Tenreiro (1560); by Linschoten (1598); and by Pyrard (1608)—the last author gives details of the luxurious habits of the Portuguese ladies of Goa, sitting on costly *alcatifs*. There may be said to be two chief kinds of carpets in India:—(*a*) PILE STITCH (the *kalins* or *galichas*), and (*b*) the PLAIN STITCH (the *daris* and *shatranjis*). The reader will find a fairly comprehensive sketch of Pile Carpets in *Indian Art at Delhi*, 1903, and with much advantage might consult the special monographs mentioned above as also the article in the *Dictionary*, while the series of admirable plates given in the *Journal of Indian Art* (1905) will fully elucidate the subject. In passing it may be said that there is no certain knowledge that the manufacture in India of high-class pile carpets dates farther back than the reign of the Emperor Akbar, of whom we read that in the year 1590 he "extensively encouraged" carpet weaving in Agra, Fatehpúr and Lahore, and again that "all kinds of carpet-weavers have settled here (? Agra) and drive a flourishing trade." [*Cf. Ain-i-Akbari* (Blochmann, transl.), i., 55; (Gladwin, transl.) ii., 30, 41–2; also (Jarrett, transl.) iii., 9.] One of the earliest and best-known carpets from the Imperial factory at Lahore is that presented in 1634 by Mr. R. Bell to the Girdlers' Company of London, and which may be seen in the Com-

Origin.

pany's hall. It bears the Company's arms and is Persian in design.

Persian Influence.

It is quite probable, however, that India possessed a carpet industry of its own, though very possibly not in pile carpets, long anterior to the advent of Persian influence (see under Multan, also Ellore). But it would be difficult if not impossible to prove either that India possessed an indigenous art of pile-carpet weaving before the date named, or that the introduced industry made much progress for many years subsequently.

Indian Influence.

It, however, survived and in time absorbed so many local conceptions as to justify the description "Indian Carpets." It has been said that the modern jail-made pile carpets have debased and degraded a system of manufacture that had been "literally and figuratively interwoven with the life of the people." But if the pile-carpet industry was only introduced and fostered by Akbar and practised by his co-religionists, and if it be the fact that it has not to the present day been taken up by any recognised Indian caste, it is difficult to see how it could be described as having become "interwoven with the life of the people."

Jail Influence.

It is much more likely that the modern jail-manufacture preserved from extinction the foreign art, than that it debased and degraded it. Milburn (*Or. Comm.*, 1813, i., 136) says that carpets were formerly an article of trade, but through "the improved state of our own manufactures and the heavy duty on Persian carpets, they are now seldom imported." It would thus seem fairly certain that by the beginning of the 19th century the Indian carpet trade (such as it had been previously), like that of Persia, had suffered greatly through the rise of British manufacturing enterprise. The craftsmen in all countries produce the standard of goods demanded of them; it would therefore be most interesting to obtain any sort of indication of the class of goods in demand immediately prior to the modern jail-made article.

Native Demand.

So far as Indian records are concerned there is nothing to show that the Natives of India to any material extent ever used, and certainly to-day they do not use, Indian pile carpets. Pyrard (*Voy. E. Ind.*, 1601–10 (Engl. transl.), ii., 248) observes that "They make carpets of the fashion of those of Persia and Ormus, but not so fine or so dear, for they use the rougher and longer wool; the patterns are however the same; they also make cotton carpets with bands of many colours." So long ago as 1655, Terry in his *Voyage to East India* (ed. 1777, 129) pointed out that the Eastern artists were essentially imitative. He speaks of their cotton and silk carpets, but makes no reference to woollen carpets. Thus, then, for the degradation of Indian art not the Government nor the Natives are responsible, but the people of Europe and America, who ask for and therefore get cheap inartistic productions,

Machine-made.

And this has possibly been confirmed definitely by an invention recently announced that will enable Oriental carpets to be produced by new and special machinery at a price far below that of the hand-loom weaver.

For the purpose of easy reference the classification employed in *Indian Art at Delhi* may be pursued in this review:—

Pile Carpets.

Panjáb.

I. Pile Carpets:—

1. ***Panjáb.***—The chief centres of the carpet industry in this province are Amritsar, Kashmir, Lahore, Multan, Hoshiarpur, Batala, Bahawalpur, Kohat and Bannu, and they have been named in their order of importance. But Peshawar has also to be added, since it is the great emporium of the Trans-frontier traffic in carpets brought from Afghanistan, Turkestan and Persia.

Lahore.

Lahore.—It has already been suggested that the manufacture of carpets at Lahore, established very possibly by the Emperor Akbar, soon decayed, and in support of that view it may be pointed out that in Honigberger's *Thirty-five Years in the East* (a work that deals specially with Lahore prior to 1852) there is no mention of an indigenous carpet industry. In this connection also it may be observed that the *Ain-i-Akbari* makes frequent reference to the Persian carpets as regularly imported into India (Blochmann, transl., 55). And it would seem probable that most of the Lahore carpets mentioned in the Records of the East India Co., and elsewhere, refer to that Trans-frontier trade and not to Indian woven carpets. A letter to the East India Co., for example, of the year 1617 (Foster. *E.I.C. Letters*, vi., 250) mentions that "carpets to be well chosen would require a long time: those which are true Lahore carpets are not suddenly to be gotten." It is possible that this may point to the survival of the Muhammadan carpet-weaving industry (introduced by the Emperor some 30 or 40 years previously), or it may simply denote the uncertain Trans-frontier supply, the carpets being picked up in the bazárs, not ordered from the weavers. At the present day, at any rate, the most prized carpets in Lahore Museum are those discovered at Peshawar, and, with the exception of a few looms in the jails, there is no local industry. A beautiful carpet, the property of Mr. G. Salting, is figured in the *Journal of Indian Art* for April 1905, and said to have come from a Lahore factory in the 17th century.

Amritsar.

Amritsar—This is probably the most important carpet-weaving centre in India, although the industry would appear to be quite modern. I have not been able to find any references to it, either in the *East India Co.'s Letters* or in the older books of travel. It may be said to be mainly in the hands of Hindus who employ European supervision, and Muhammadan weavers who work (for the most part) on the contract system. It is affirmed that the utmost care is taken in securing the oldest and choicest patterns and in selecting the wool and the vegetable dyes. Pashm (the fine shawl-wool) and camel's hair are used for the best descriptions, and, as with all Indian carpets, the work is done entirely by hand. There are several factories, some of which possess as many as 300 looms, others not more than eight or ten. The industries of *Hoshiarpur* and *Batala* may be taken as off-shoots of the carpet-weaving of Amritsar.

Pashm.

Hoshiarpur and Batala.

Kashmir.

In *Kashmir* there are several factories which turn out extremely beautiful work. The trade is in Srinagar, and the factories are practically all owned by Europeans, and were originated to find labour for the shawl-weavers who were thrown out of employment through the decline in the demand for their hereditary craft manufactures. The plates in the *Journal of Indian Art* (1905), July and October (six in number), fully exemplify this style. The fine old carpets preserved in the Asar Mahal of Bijapur are believed to date from 1657 and to have come from Kashmir. If this be correct the Delhi Emperors may have established a factory in the "Happy Valley" 250 years ago. The carpets in question are fully representative of the styles usually designated Mughal. [*Cf. Journ. Ind. Art.*, *l.c.* Jan.]

Multan.

Multan is often spoken of as having an indigenous carpet industry, or at all events one which dates prior to the introduction of the Persian craft. It thus seems probable that the so-called Multan conceptions were modelled on rugs brought long ago from Turkestan, in consequence of the Pawindah trade. The narrow shape, bold yet not clear detail, and vivid colouring are characteristics of both Multan and Turkestan carpets. On the other hand, Mr. Latimer speaks of the household industry of Multan as characterised by names of tools, designs, and methods of weaving that are clearly of Persian origin. Examples of Multan and Dera Ismail Khan carpets are to be seen in the *Journal of Indian Art* (1905), July and October numbers. *Bahawalpur* carpets differ but little from those of Multan. In passing, mention may be made of a recent attempt to utilise in the local carpet industry the vast supplies of the floss of ***Calotropis gigantea*** (p. 207).

Bahawalpur.

Peshawar.

Peshawar is, as has been already observed, the emporium for Trans-frontier rugs, notably Turkoman or Tekke (commonly called Bokhara) rugs and the expensive Herat and Yarkand carpets. In *Kohat* and *Bannu* and a few other places along the North-West Frontier a peculiar form of rug is produced called *nakhai*, in which loops of the weft threads are made to protrude an inch or so between each pair of the warp strands. The designs are usually in purple or crimson with black, yellow, and sometimes green. The result is crude but not inartistic.

Kohat and Bannu.

Rajputana and C. India.

Jaipur.

Bikanir.

2. ***Rajputana and Central India.***—From the jail-looms of *Jaipur* excellent rugs and carpets are produced. Some of the most historic of pile carpets are, it is said, in the possession of His Highness the Maharaja. In the *Journal of Indian Art* is given a coloured illustration of one of the gems of that series. *Bikanir* produces the best carpet-wool in India, and is thus eminently suited to become a great weaving centre. The Central Jail has for some years taken a high place for the quality and artistic merit of its carpets. The patterns followed are mostly those of the famous book on Oriental Carpets published by the Imperial and Royal Austrian Commercial Museum, and the carpets produced have attained a position of great merit, through the enlightened interest taken in the subject by His Highness the Maharaja. *Ajmir* jail also produces many excellent carpets and beautiful rugs.

Ajmir.

Sind and Baluchistan.

3. ***Sind and Baluchistan.***—The carpets manufactured in Sind closely resemble those made in Multan. They are said to be the cheapest, coarsest, and least durable of all Indian carpets. The Baluchistan rugs are in design Turkoman, not Persian. They arrive by camel-caravan at Quetta (and Peshawar also) from Afghanistan, mainly Seistan. They are made mostly of goat's hair, which gives

them their singularly beautiful lustre. But the Baluchistan carpets and rugs have deteriorated sadly from their pristine beauty and excellence.

U. Prov.

Agra.

4. ***United Provinces.***—Several centres are noted for their carpets, such as *Agra, Mirzapore, Jhansi, Jabbalpur* and *Allahabad. Agra* is one of the three centres at which the Emperor Akbar endeavoured to establish a carpet industry. In the *Journal of Indian Art* (Oct. 1905) two plates are given of carpets turned out at this centre. To this day the superior designs of its jail-made carpets are a striking refutation of the charge brought against the jails of having degraded the carpet industry. Recently a factory has been established under European management, to utilise the skilled labour outside the Central Jail. It appears from the E.I.Co.'s letters that Agra was an important distributing centre for other than locally made carpets. Thus the Company's servants of Surat purchased Lahore carpets at Agra (*E.I.C. Letters, l.c.* 250), and the Portuguese merchants of Goa took various carpets from Agra in exchange for jewellery.

Mirzapore.

Mirzapore may perhaps be described as the headquarters of the cheap commercial modern carpets of India. In the *Journal of Indian Art* (July 1905) will be found a highly typical representation of 90 per cent. of the carpets of this centre. There are numerous private factories (both Native and European) engaged in the industry, but the patterns have of late years been supplied mainly by firms in Europe and America, so that the deterioration in quality noticeable for many years past may be spoken of as a direct consequence of this dictation.

South India.

5. ***South India.***—The carpets exported from Masulipatam and Cocanada were those that first attracted attention in Europe as being specifically Indian, and doubtless a century ago they were made at much the same centres as to-day.

Ellore.

Three Classes of Carpets.

At *Ellore*, where the weavers are Muhammadans but very poor, the business is done by advances. Three classes of carpets were shown to me during a visit made in connection with the Delhi Exhibition:—(*a*) carpets of foreign design, mostly Persian, and defective in every direction: (*b*) carpets collectively known as of Ram Chandra design.

Ram Chandra Carpets.

In the *Journal of Indian Art* will be seen (July and October numbers) examples of these carpets, especially those from *Vellore.* The same journal (viii., pl. 50) shows a *Coromandel* carpet which doubtless belongs also to the Ram Chandra group. These, as a rule, were good, the colours being well chosen but the quality very low, not more than 5 or 8 threads to the inch: (*c*) the third type represented by an old rug which was so woven (by what the weavers call the "velvet method") as to simulate the fine texture of the old grass-mats. This was probably the original style of Rajamundry and Ellore.

Masulipatam.

Masulipatam once turned out some of the finest carpets in India, but foreign exporters are said to have degraded the industry by supplying cheap and bad material. At the writer's suggestion the Madras School of Arts reproduced for the Delhi Exhibition two fine Ram Chandra carpets, the originals of which are preserved in the Madras Central Museum. The prevailing features are the rich deep brown-red of the field and the quaint border of rosettes of flowers.

Malabar.

Malabar is said to have formerly produced the only pile carpets of pure Hindu design made in India. They are apparently not now manufactured. In the account of Sir George Birdwood—his Life and Work—as given in the *Journal of Indian Art* (viii., pl. 50), a corner of a beautiful Malabar carpet is shown.

Bangalore.

The jail in *Bangalore* in Mysore State has for long been noted for the good quality of its carpets. One shown at Delhi was distinctly a Hindu design with a Ram Chandra border.

Deccan.

Warangal Rugs of Hyderabad.

6. ***The Deccan.***—*Hyderabad* formerly produced the wonderfully fine silk rugs known as WARANGALS. The *Journal of Indian Art* (Jan. and July, 1905) shows three carpets of this school. This charming textile has the property of changing colour according to the point of view. The carpets at present produced, while possessing certain features of their own, are far inferior to the old work. The scheme of colour is scarlet, yellow and white. In the work just quoted will also be found highly characteristic examples of Hyderabad carpets.

Western India.

7. ***Western India.***—It is probable that the Persian traders very early established themselves along the western coast of India, and there produced carpets under the patronage of the Emperors, Princes, and Nobles of India, very possibly long before they were made in Agra and Lahore. Certainly *Cambay* was one of the earliest seats of the craft, for according to Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), i., 47, 60), who travelled in India about 1584, the people of that

Ahmedabad.

Poona.

city made "*alcatiffas*" (that is, long-pile carpets), "but they are neyther so fine nor so good as those that are brought to Ormus out of Persia." *Alcatif*, according to Crooke (*Hobson-Jobson*, 11), was a name much used in India for carpets during the 16th century. Bombay, except in the School of Art, does not produce carpets. *Ahmedabad* is mentioned very frequently in the E.I.Co.'s letters and records as a centre in the carpet industry. At present there are only one or two very small factories, and the carpets turned out are sent chiefly to America. In *Poona*, the Yeroda Jail has produced some excellent work, mostly copies of the old carpets in the possession of the Asar Mahal and Jamai Musjid of Bijapur. Thus it may safely be affirmed that the Poona jail, instead of exercising a debasing influence on the carpet industry, has conserved what might otherwise have been lost.

Cotton and Woollen Carpets.

II. Cotton and Woollen Carpets in other than Pile Stitch.—The *daris*, *shatranjis*, etc. Just as the pile carpets referred to above (the *kalins*, *kalichas* or *galichas*) are usually in wool but sometimes in cotton, so the *daris* and *shatranjis* are mostly in cotton though sometimes in wool.

Tapestry.

Possible Future Trade.

As already suggested, it is probable that the Indian carpets, prior to the Muhammadan invasion, belonged almost exclusively to the description here indicated. Stein (*Ancient Khotan*, 1907, xxiv., 337, 398) describes and illustrates a fragment of a woollen carpet found by him in the ruins of the Niya site, which were engulfed by sand about the 3rd century. This appears to be in plain stitch, and recalls in design the embroidered rugs of Hissar and Sirsa. So also another rug found at the Niya site is described as of the regular Indian *dari* type, and seems a brocaded cotton textile much closer to the woollen fabrics of Tibet than to anything made in India (*l.c.* 333–4, 397, pl. lxxv.). Terry, in his *Voyage to E. India*, about 1615 (ed. 1777, 127, 186), mentions the cotton carpets in "fine mingled colours," but makes no mention of the woollen or pile carpets. Mandelslo (*Travels*, 1683, in Olearius, *Hist. Muscovy, etc.*, 1662, 39) speaks of the floor of the house in which he resided in Ahmedabad as being covered with tapestry and the pillars draped in silk stuffs. Plain stitch carpets and rugs are universally used by the poorer Muhammadans as praying-carpets (*jainamaz*), and in consequence have often more art shown in their composition than might be anticipated. Some of the more noteworthy centres of production are Rangpur in Bengal; Agra, Aligarh, Bareilly and Bulandshahr in the United Provinces; Jaipur and Bikanir in Rajputana; Bahawalpur, Multan, Gujarat, Sialkot, and Peshawar in the Panjáb; Dharwar, Belgaum, Ahmednagar, Kaladgi and Cambay in Bombay; and Vadavedi and Adoni in Madras. Many modern and ancient *daris* of great beauty were shown at the Delhi Exhibition. One of the most interesting and artistic was the *shatranji* said to have been presented by the Emperor Auranzeb in 1626 to the Jamai Mosque of Bijapur. This has a rich Indian red field with, suspended from the top of each *jainamaz* section, a lamp symbolical of the faith. It would appear to have been woven more like tapestry than an ordinary *dari*, and to have had the patterns separately made and interwoven in their places on the loom. These and such-like give a lesson that might well be learned by the manufacturers of cotton carpets throughout India, namely, that if they would abandon the striped forms and produce richer and more varied designs, such as those of the Poona Jail *daris*, a larger market might be found in India itself, and in foreign countries as well, than has as yet been secured. There can be little doubt that neatly and substantially woven cotton carpets would be more acceptable to the inhabitants of tropical countries than woollen ones, because cheaper, cooler, cleaner and (under a tropical climate) more durable. Further, cotton plain carpets would doubtless be preferable to cotton pile carpets. Much, therefore, remains to be done in the direction of developing the Indian trade in cotton carpets and rugs. [*Cf. Monographs, Cotton Industries*:—Banerjei, *Bengal*, 1898, 33–4; Silberrad, *N.W. Prov.*, 1898, 24–6, f. 36; Enthoven, *Bombay*, 1897–9, 11, 33, etc.; Thurston, *Madras*, 1897, 7–11; Latimer, *Monog. Carpet-making Pb.*, 1907, 1–3.]

Woollen Daris and Shatranjis.

Woollen Daris and Shatranjis, though not met with very abundantly in India, are still made and much admired. The Bhutias of Darjeeling and the people of Nepal and Eastern Tibet weave strips of woollen thick cloth in various designs, which, when sewn together into sheets, closely resemble Kurdish *khilims*. Mention has already been made of a fragment of a rug found by Stein in the ruins of Niya, Khotan, as recalling the Bhutia woollen rugs. The people of Darjeeling proper also weave thick *chadars* of white and blue

Bikanir.

that are very beautiful and find a distinct place among the art treasures of the residents in the eastern side of India, but are only rarely seen elsewhere. In *Bikanir*, plain-stitch rugs are regularly woven in wool, but in the same form as the cotton *daris*. The pattern most often employed recalls the barbaric cross-stitch embroideries of Hissar and Sirsa. In Quetta, rugs and camel saddle-cloths are largely woven in wool and richly ornamented with shells. They are in stripes with patterns worked within, and to all intents and purposes should be classed as *khilims*.

Trade

Exports.

Imports.

Trade in Carpets and Rugs.—The only available details concerning the export trade in Indian-made carpets and rugs refer to (*a*) Mats and Matting of vegetable fibre: (*b*) Carpets and Rugs of wool. A summary of available statistics on the former subject will be found on page 778, so that it is only necessary to give here such particulars as are available regarding the woollen carpets. The quantities are always estimated by pound weight, not number. The total weight exported from India to foreign countries in 1899–1900 was 1,691,577 lb., valued at Rs. 23,73,289; in 1903–4, 1,878,202 lb., Rs. 26,04,576; and in 1906–7, 1,603,330 lb., Rs. 20,89,516. In the last year, goods to the value of 11 lakhs of rupees went from Bengal, 6 lakhs from Bombay, and 2 lakhs from Madras. The increase in the total quantity and value of carpets, etc., exported in 1903–4 was due to an improvement in the trade in these articles with the United Kingdom. The latter took in 1899–1900, 1,180,779 lb., Rs. 17,21,987; and in 1903–4, 1,549,658 lb., Rs. 19,54,560; but in 1906–7 the quantity fell again to 1,346,144 lb., Rs. 15,66,113. The exports to Ceylon fell from 235,070 lb. in 1899–1900 to 2,980 lb. in 1903–4; and in 1906–7 rose to 4,303 lb. The United States took quantities varying from 223,551 lb. in 1899–1900 to 401,340 lb. in 1901–2; 266,526 lb. in 1903–4; and 174,727 lb. in 1906–7. There is also a fairly extensive import trade in Carpets and Rugs, chiefly to Burma and Bombay, from the United Kingdom and Germany. It amounted in 1899–1900 to 842,716 lb., Rs. 8,46,013; in 1903–4 to 887,192 lb., Rs. 8,96,738; and in 1906–7 to 1,016,055 lb., Rs. 10,56,679.

D.E.P., ii., 183.
Wild Safflower.

Cement.

CARTHAMUS OXYACANTHA, *Bieb.*: *Fl. Br. Ind.*, iii., 386; *Ann. Rept. Indust. Mus. Calc.*, 1899–1900, 7–8; Watt, *Agri. Ledg.*, 1901, No. 12; *Ind. Art at Delhi*, 1903, 231–3; COMPOSITÆ.

Wild Safflower (the *kuzburai*, *kháreza*, of the Trans-Indus and *karar*, *políyan*, *polí*, *kantiárí*, *kandiara*, *mian kalai*, etc., of the Panjáb) is a native of the drier arid tracts of North India. In Peshawar district it is peculiarly prevalent, the spinose clumps constituting an objectionable feature of the grassy tracts. Where met with in fair abundance the seeds (or to be more correct, fruits) are collected on account of the large quantity of oil which they contain. This oil is the chief ingredient in the Afridi wax-cloth presently to be described, and may also be used as a glass cement.

D.E.P., ii., 183–95.
Cultivated Safflower.

C. tinctorius, *Linn.*; *Cnicus Indicus*, Rumph., *Herb. Amb.*, 1750, v., 215–20, pl. 79 (2); Mukerji, *Handbook Ind. Agri.*, 1901, 292–5; Mollison, *Textbook Ind. Agri.*, 1901, iii., 98–101; Abbey-Yates, *Agri. Ledg.*, 1904, No. 11. The Cultivated Safflower, Bastard Saffron, Carthamine Dye, the *kusum*, *kásumba*, *kusúmbo*, *kusubi*, *kardi*, *kábri*, *ma*, *sufir*, *kar* or *karar*, *sendurgam*, *agnisikha*, *hebu*, *su*, *subán*, etc. The Arabic *usfúr* (Ibn Baithar, 1200 A.D., ii., 196) assumed various forms and gave us the English name:—thus *affiore* (Pegolotti, *Pratica di Mercat.*, 1343, 372), *asfiore*, *asfrole*, *astifore*, *asfiori*, *zaffrole* or *zaffrone*, *saffiore* and finally *safflower*. Another Arabic name, *kurtum* (used in the Makhzan), may have originated the botanical name ***Carthamus.*** The most prevalent Indian vernacular name *kusum* comes direct from the Sanskrit *kusumbha.*

Cnicus versus Carthamus.

Purgative Oil.

History.—" This plant is the *kusumbha* of Sanskrit writers, who describe the seeds as purgative, and mention a medicated oil " (*Pharmacog. Ind.*, ii., 308). That is the commonly accepted opinion, but on the other hand Dutt (*Mat. Med. Hind.*, 307) makes no mention of the special knowledge possessed by the Sanskrit medical writers, and it may be added the medical treatise which constitutes *The Bower Manuscript* (Hoernle, transl.) is silent both as to the *kusumbha* plant and its oil. The Greek *cnicus* (*Paulus Ægineta* (Adams, transl.), iii., 178) by most authors is identified with the Bastard Saffron. The early Greek authors speak of *cnicus* as a spinose plant, but Dioscorides (iv., 187 (ed. Sprengel), 1829, i., 680) mentions that it was a pot-herb and purgative medicine. Galen, Avicenna, Serapion, Rhases, etc., follow Dioscorides, but most Arab writers add the additional property that it is alexipharmic. Mesua, who lived at Bagdad in the 10th century, wrote a great work on the Medicine of the Greeks and Arabs. He opens his account of *cnicus* (Marinus, transl., 1562, 74) by observing that the plant is both wild and cultivated, but that the so-called Indian *cnicus* is not *cnicus* at all. He then observes that the seed is the most valuable, especially the large white kind. The figure given by Marinus is an excellent representation of ***C. tinctorius.*** Carthamus was retained in European pharmacy down to comparatively recent times. De Candolle (*Orig. Cult. Plants* (Engl. transl.), 164), following Targioni-Tozzetti (*Cenni Storici, Intro. di Varie Piante*, 1853, 88), thinks the determination of the Greek *cnicus* with Carthamus very doubtful. Pliny distinctly says the oil was used in Egypt in place of castor-oil, but he adds the plant was not known to the Romans. It may be added that Pliny writes it *cnicus* and Columella *cnecus.*

Abyssinian Wild Plant.

Indian Wild Plant.

Chinese Plant.

The grave-cloths of the ancient Egyptian mummies are dyed with safflower, and fragments of the plant and the seeds have been found in tombs. [*Cf.* Rawlinson, *Hist. Egypt*, 1881, i., 62–3; Hehn, *Kulturpfl. und Haust.* (ed. 6), 261; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 678–84.] The Sanskrit authors describe the *kusumbha* oil as purgative, so that identical properties were assigned to it in Egypt, Africa and India. An Abyssinian so-called wild species (***C. lanatus***, in Schweinfurth, *Fl. Æth.*, 1867, 143) has by some writers been accepted as the original stock of the cultivated plant; so also, and with equal if not greater force, ***C. Oxyacantha***, the Indian wild species, has been advanced as the source of the cultivated plant. De Candolle accordingly came to the opinion that since an undoubted ancient cultivation had been established for both India and Africa it was probable the true ***Carthamus tinctorius*** might be found wild in the intermediate country Arabia. He accordingly cites in part support of that suggestion the circumstance that an author quoted by Ibn Baithar (the Arab, Abu Anifa) mentions both a wild and cultivated form as met with in that very country. In China there would seem little doubt safflower (*hung-hua* or red-flower) was introduced about the 2nd century B.C. [*Cf.* Breitschneider, *Europ. Bot. Disc. in China*, 1898, 4 ; also *Value Chinese Botanical Works*, 1870, 15.] Japan received it from China, but according to Rein (*Indust. Japan*, 176–7) it can hardly be regarded as more than a botanical curiosity in that country—the cosmetic *beni* being manufactured from foreign (mostly Indian) supplies of safflower. [*Cf.* Milburn, *Or. Comm.*, 1813, ii., 238–9 ; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 208 ; Lacaita, in Maw, *Genus Crocus*, app. v. ; *Der Tropenflanzer*, viii., 511 ; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 272.]

Two Crops.

Cultivated Indian Races.—There are two main conditions, one grown purely and simply for its flowers—the safflower dye of commerce, the other for its oil-yielding seeds, the *kusum* or *carthamus* oil of trade. The former is fairly extensively produced in Bengal, the United Provinces and the Panjáb, while the latter is chiefly met with in the Central Provinces and Bombay. But while these two conditions or properties seem well understood agriculturally, dried specimens of the plant grown for the one or the other purpose are indistinguishable. Moreover several races occur under each of these states, such as with small, very hard spinose leaves (much as in ***C. Oxyacantha***) or with large, soft, almost non-spinose edible leaves. Some have narrow, hard and sharply spinose bracts, others broad almost entire bracts. Still, however, most of these

Oil-yielding Forms.
Dye-yielding Forms.
Spiny and
Grown as Pot-herb.
The Dye and the Oil Crops.

conditions recur again and again with the oil-yielding and the dye-yielding races, so that no set of characters can be given, to separate the groups that belong to the one or the other. Speaking broadly, however, the oil-yielding forms are more spinose than the dye-yielding, and have usually yellow-coloured flowers, the dye forms being orange or even yellow tinged with scarlet. The dye-yielding plants require a rich soil and humid atmosphere, hence the loss of spines may be due to high cultivation and protection. In the young state the smooth-leaved spineless forms are edible, and in some parts of the country, notably Burma, they are mainly, if not exclusively, grown as pot-herbs. But within each of the great centres of production there may be both smooth and spinose forms. Thus in Bengal a spinose dye-plant is known as *kuthi* or *kutela* and a spineless dye-state called *murdi*, *murilla* (= shaved), *bhuili*. In the United Provinces the spineless *kusum* affords both dye and oil, while the spinose form distinguished as *kasar*, *kasur*, is grown for its oil-seeds only. In Berar (Sule, *Monog. Dyes and Dyeing*, 1895–6, 1) the spiny *kati kardi* yields an inferior dye and good oil, while spineless *bodki* gives a superior dye. In Bombay two great centres of production exist, viz. on the rich alluvial loams of Kaira and Ahmedabad, in Gujarat, where the spineless red-flowered dye-yielding *kusumbyachi* or *kusumba* prevails, and the Deccan, with its spiny *sadhi* or *kardai*, an oil-yielding crop. [*Cf.* Fawcett, *Monog. Dyes and Dyeing*, *Bomb.*, 1896, 25–9.] Briefly Bengal is (or rather was) the source of *kusum* dye, and the Deccan of the safflower oil. These products may therefore be dealt with separately :—

Safflower Dye.
Safflower or Carthamine.
Wedding Garments.

I. THE DYE—Safflower or Carthamine.—So much has been written regarding the cultivation and utilisation of safflower that a brief review of the modern results seems all that is called for. But it may be explained that the various provincial Governments of India issued, in 1896, monographs on "Dyes and Dyeing," and that these will be found to have special chapters on safflower. So also *The Agricultural Ledger* (1904, No. 11) may be described as a compilation of the more important passages from modern writers, and it thus amplifies the particulars recorded in the *Dictionary*. The remarks that follow will accordingly be restricted as far as possible to facts calculated to assist the merchant or cultivator, but will abstain from republishing technical details, especially methods of dyeing. But in this connection it may be observed that safflower has preserved its position in spite of foreign dyes, mainly through the colour being viewed as more or less sacred for wedding garments.

Cultivation.
Bengal.
Assam.
C. Prov.
U. Prov.
Panjáb.

Cultivation.—Safflower, though by no means so important a crop as in former years, is still grown to a fair extent in the Dacca Division of Bengal, and here and there throughout the Province. Taylor (*Topog. and Stat. Dacca*, 1840, 133–5) gives an interesting account of the production during the prosperity of the industry. The best quality was grown in the vicinity of Pattergotta. Safflower is also met with in the Surma Valley and in Manipur, but not in the Assam Valley proper. In the Central Provinces it used to be extensively produced in Raipur and Chhindwara, but the area in recent years has been greatly curtailed. In the United Provinces of Agra and Oudh, though met with now and again, it assumes importance in Meerut only. In the Panjáb it is to be seen in most districts, but Hoshiarpur and Amballa are perhaps most spoken of, and the safflower of the hills, especially that of Kabul, has the best reputation. The wild safflower is also a product of considerable value. In Berar safflower is regularly cultivated, though by no means to the extent formerly witnessed. In Madras it may be seen here and there, and in Burma it is more grown as a vegetable than as a dye. But in Bombay there are two centres of production. The cultivation for dye is not extensive, and is confined to Gujarat and the Karnátak, Kaira being perhaps the most important district. Dr. Hove (1787) refers to the dye of *Carthamus* being then used in Gujarat to dye *pagris*. But the Bombay dye is regarded as much inferior to that of Dacca in Bengal.

Berar.

Madras.

Burma.

Bombay.

Methods.

Methods.—The systems of cultivation pursued are so very similar throughout India that the subject may be treated collectively, the remark being made that it differs province by province, according to the amount of attention given and the local value of the crop. It is sown along with other *rabi* crops such as gram, wheat, barley, tobacco, opium, chillies, carrots, etc., from about the middle of October to the end of November, or in Chittagong as late as January. It requires a light sandy soil, and one which possesses a fair amount of moisture. In the better cultivation the land is lightly manured and ploughed repeatedly from May or June till sowing time. It is either sown broadcast or drilled, the latter in Bombay, 3 drills 18 to 22 inches apart of safflower alternating with the subsidiary crop. In the less important cultivation it forms single drills or surrounds other crops, its spiny character serving the purpose of a protecting hedge. On the central flowering head appearing, this is nipped off in order to cause lateral shoots and a more copious flowering. The prunings and thinnings are eaten as a pot-herb. The crop comes into season in January to April, or even May, and is plucked every second or third day. Delay in collecting the flushings of florets causes loss in dye. Rain during the flowering is also very injurious. The florets being picked after fecundation, the seed ripens and yields a supplementary crop. The average yield of dried florets is in Bengal about 80 lb. (according to Mollison (*l.c.* 100) from 100 to 120 lb. in Bombay), per acre, and of oil-yielding seeds (fruits) 400 to 600 lb. The first and the last pickings of florets are by most writers considered inferior in dye merit to those in mid-season.

Seasons of Sowing.

Thinnings Eaten.

Seasons of Crops.

Yield.

Manufacture.

Manufacture.—The day's collection is carried to the homestead and partially dried in the shade. It is then rubbed between the hands, placed on an arrangement of basket filters, and pure stream (or slightly acidulated) water poured over. This removes the most soluble of the useless yellow dye, but care must be taken that the water is not alkaline, or the red dye also may be washed out and the florets rendered useless. When the water passes through clear the washings are regarded as complete. The florets are then partially dried and pressed into the small characteristic cakes met with in trade; then the drying is completed. According to Taylor the florets in his time were saturated with water in the evening and next morning trodden underfoot, and this was repeated for four or five days until the water ran off clear.

Florets Washed.

Dried and Caked.

In centres where little attention is given to the crop the florets are not washed, and instead of being made into cakes, are formed into balls or sold as loose powder. The presence of the yellow dye lowers the value and increases the weight. In Bombay a curious sytem prevails which consists in rubbing into the florets a certain amount of *til* oil (a *tola* weight to a pound of the florets). Mollison observes that this is the practice in Gujarat, but it is known to produce loss of colour. This very possibly

Oil rubbed into Florets.

accounts for the lower price of Gujarat safflower as compared with that of Dacca. Apparently also the yellow dye is not removed until a later stage, and the oil would thus seem to serve no useful purpose. It recalls, however, the practice described by Rumphius (*l.c.* 217), where the people of the Malay are spoken of as adding the bruised oil-yielding seeds of *Aleurites triloba* to prevent the florets from crumbling to dust.

Price.

Safflower-dye cakes (Gujarat) are sold in Bombay at 2 to 2½ lb. per rupee. The value is estimated according to the colour that a given weight will impart to a pound of cotton.

Trade in the Dye.

Early Statistics. Record.

Recent Returns.

Trade in Safflower Dye.—Madder in Europe and Safflower in India are the dyes that felt immediately the effect of the discovery of chemical colours. This, in the case of the Indian product, may be exemplified very briefly. Half a century or so ago, safflower became a fairly important commodity. It is curious, however, that none of the early travellers in India mention the dye. The first botanist who describes its cultivation in the East would appear to be Rumphius. Milburn records the exports in 1804 as having been 247 cwt., valued at £1,460, or £5 18*s*. 5*d*. a cwt. Four years later the exports were 1,070 cwt., valued at £4,532, or £4 4*s*. 8*d*. a cwt. An import duty at British ports was levied of 7*s*. 4*d*. a cwt. In 1821–5 the exports from India appear to have been 6,185 cwt., and in 1837 they stood at 7,962 cwt. Passing over a period of close on forty years, we next learn that the Indian traffic had become (in 1874–5) 10,157 cwt., valued at Rs. 6,50,827 (or expressed at the rate of exchange that then prevailed, approximately £60,000); but a sudden change took place, for the very next year the traffic fell to 2,914 cwt., valued at Rs. 1,63,528, and ten years still later (1884–5) had become 1,459 cwt., valued at Rs. 83,083. Within the past six years a revival in quantity seems to have set in, since the exports were in 1899–1900, 1,993 cwt., valued at Rs. 34,572, and in 1903–4 the corresponding figures were 4,313 cwt. and Rs. 67,506. They have since fallen, however, to 3,670 cwt., Rs. 50,389, in 1906–7. A remarkable feature of the traffic thus briefly outlined may be said to be the decline in the prices realised—viz. from £5 18*s*. 5*d*. a cwt. to the price in 1901–2, viz. Rs. 20 or £1 6*s*. 8*d*. a cwt. Even twenty years previously (1881–2) the price realised was nearly double the rates that rule to-day. It is not, therefore, to be wondered at that safflower has ceased to be an important crop, and that but for the local markets the dye might by now have disappeared from India as completely as has the madder from Europe.

Japanese Demands.

Price.

Carthamin.

The exports from India go mainly to Hongkong, but a recent demand from Japan has been viewed as a favourable prognostication for the future. The local market continues fairly large in spite of foreign mineral dyes, owing to the fact that safflower is associated with the social customs and religious feelings of the people. The varying quality would seem to depend first of all upon the climate and soil of the locality where produced; next, the care pursued in collection, and the method of preparation followed. With all the finer samples the yellow dye has been washed out and the florets purified. This has naturally the effect of lowering the weight and concentrating the dye. Washed safflower must accordingly fetch a higher price than the impure and adulterated dye. In further purification of the dye a second yellow colour is precipitated and removed by means of acetate of lead. *Carthamin*, the valuable red colour, may then be extracted in a pure form by making use of its

Alkali Used.

solubility in alkaline solutions, and insolubility in pure or acidulated water. In India the alkali used is almost invariably that prepared by incinerating *bajra* (*Pennisetum*) stems or *chir chira* (*Achyranthes*, see p. 49), but crude natural carbonate of soda known as *sajji-mátti* is also employed. It would seem probable that the isolation and utilisation of carthamin is in India a comparatively recent discovery.

Oil.

Bombay.

Ahmednagar, Poona, Sátára, Bijápur, Dhárwár, and Belgaum.

C. Prov.

II. THE OIL.—The seeds from the dye-yielding plant are collected and form a supplementary return, but, as already stated, in some parts of the country, notably Bombay, an oil-yielding crop is specially grown. Mollison (*l.c.* 98) says, "Safflower is the most important oil-seed crop in the Bombay Presidency. The area is usually from 500,000 to 600,000 acres annually. The chief centres of cultivation are in the black-soil *rabi* lands of Ahmednagar, Poona, Sátára, Bijápur, Dhárwár, and Belgaum." It is subordinate to the crops with which it is associated such as *juár*, wheat or gram. "It therefore participates in the general cultivation given to these crops." "Usually three consecutive rows of safflower alternate with 9 or 15 or 21 consecutive rows of the principal crop." In the Central Provinces the area of special oil cultivation has recently been greatly curtailed, so that the Deccan production may be accepted as alone of importance, though of course the oil of the dye crop must not be entirely ignored.

Two Oil Plants.

Extraction of the Oil. Two Methods.

Manufacture.—It has been customary to find Baden-Powell's statement (*Pb. Prod.*, 421) that two oil-yielding forms of this plant exist —the wild and the cultivated—repeated by Indian writers without its being observed that an admission was being thereby made to which only the most cursory attention had been subsequently paid. But in addition to there being two distinct sources of the oil there are also two widely different methods of preparation. In the one the seeds (fruits) are simply subjected to cold-dry pressure either before or after they have been husked. The yield is said to range from 20 to 30 per cent., but both the quality of the oil and the value of the cake depends upon the seed being husked. The second process is a hot-dry extraction, or rather a crude downward distillation. The seeds are placed within an earthen pot, and this is inverted over the mouth of a similar pot placed within the ground, the two pots being separated by a perforated plate. Over and around the inverted pot is piled some fuel, and on this being ignited, the seeds are partly roasted; the oil in consequence drains from them and accumulates in the lower or submerged pot.

Description.

Culinary Oil.

Sweet-oil.

The cold-drawn oil has a clear straw colour, with a sp. gr. of ·9224 at 15° C. According to Hooper (*Agri. Ledg.*, 1904, No. 11, 160), it "possesses pronounced drying properties. It readily saponifies with alkalis, forming a fairly good soap, and the free fatty acids have some of the characteristics of the linoleic acid obtained from lineseed. The oilcake retains 11·55 per cent. of the natural oil, and is not contaminated with earthy impurity. The nitrogen amounts to 3·19 per cent., which is equivalent to 19·94 per cent. of albuminoids." It is an oil extensively used for culinary purposes, and to adulterate *ghi* or *til*. Moreover, safflower, earthnut, and *til* are often mixed together and the oil expressed; this constitutes the sweet-oil of Bombay. Safflower oil is also said to be an ingredient in Macassar hair-oil. Inferior qualities are used for illumination. The hot-extraction oil is about one-fourth larger than the cold, but is useless both for burning purposes or for food. It has, in fact, acquired a

Roghan.

new property, and been converted into a substance very serviceable for greasing well-ropes, leather well-buckets, etc., purposes for which the cold-drawn oil is quite unsuited. In other words, the oil has been converted into what is known as *roghan*—a substance employed to prevent leather from hardening on its being exposed to the action of water or of a damp atmosphere.

Oil.

Oil of Wild Safflower.—In the Northern Panjáb, more especially Peshawar, a very different process is adopted from that just detailed for the manufacture of *roghan.* The *polli* oil (the oil of *C. Oxyacantha*) expressed by the cold process is placed in earthen vessels and boiled continuously for twelve hours. The vessels are so placed that it is not possible for a flame to reach the boiling liquid, and the temperature is kept low and uniform. In time it emits volumes of white pungent vapour, so exceedingly disagreeable that the manufacturers are compelled to conduct their industry under special license and in a place assigned to them remote from human dwellings. On the oil being cooked to the required extent, and while still boiling hot, it is thrown into large shallow trays containing cold water. It swells up into a jelly-like substance, the *roghan* of Northern India. This is stored in tin cans and sold to the manufacturers of the so-called Afridi wax-cloth.

Afridi Wax-cloth.

Oil Paint.

Application Cloth.

Wax-cloth.—It would occupy too much space to repeat the accounts published in *The Agricultural Ledger* (1901, No. 12, 393-414) and *Indian Art at Delhi*, 1903 (229-34), regarding this curious little industry. The facts made known in these publications prove that we have been incorrect in affirming that the Natives of India were unaware of the drying property of certain oils in the manufacture of paint with mineral pigments. But in the Afridi wax-cloth the paint is not applied by a brush but by means of an iron style. The rapidity and accuracy with which the pattern is elaborated by threads of plastic and coloured *roghan* has to be seen to be appreciated or understood. The skilled artist can work from right to left or left to right with equal ease, and, just as in penmanship, the thick downward strokes and the fine upward hair-lines are each made to occur in their proper places in the elaboration of the pattern with which the fabric is being covered. Where two or more colours have to be given, the operator usually applies all the patches or lines of one colour before he proceeds to use the second or the third shade. The half-finished table-cloth or fire-screen may in consequence often appear a bewildering production, since it may be impossible to discover the actual pattern in the operator's mind.

Castor-oil *Roghan.*

In passing it may here be added that in Baroda, castor-oil, and in Kach, linseed-oil, are similarly made into the *roghan* used in the fabrication of the wax-cloths of these localities. Experiments conducted in the Industrial Museum, Calcutta, have revealed the fact that the oil of the wild safflower possesses no special properties over those of the cultivated plant.

Linoleum.

Cloth for Linoleum made in India.

It would further seem that in the Afridi wax-cloth India possesses the nucleus of a possible large new craft, that of producing wax-cloth, water-proofing materials and linoleum, from local materials and possibly by means of the expert craftsmen who from time immemorial have turned out the goods here indicated. The jute mills of Calcutta prepare and export the cloth required by the wax-cloth and linoleum manufacturers of Europe and America. India, moreover, will be seen to import a by no means insignificant amount of the specially prepared wax-cloth and linoleum (oil-cloth and floor-cloth) made on the jute textiles exported from India for that purpose. In 1876–7 these imports were valued at only Rs. 17,620; in 1901–2 they came to Rs. 5,74,306; in 1903–4 to Rs. 4,17,788; and in 1906–7 to Rs. 6,20,305. Surely the effort to participate in so prosperous a traffic is worthy of attention.

Edible Seed.

Edible Seed and Cake.—*Carthamus* seeds, especially after being roasted, are eaten, but are most valued as a food for poultry, though, as already observed, the tender shoots are prized as a pot-herb or salad. Mollison makes the remark that cattle have to be educated to eat the cake, but that it has the advantage of keeping well and does not get mouldy. It is highly valued as a manure.

[*Cf.* Leather, *Agri. Ledg.*, 1897, No. 8, 159; Duthie and Fuller, *Field and Garden Crops*, i., 51–4, pl. xiii.; *Monographs, Dyes and Dyeing*:—Banerjei, *Bengal*, 73; Duncan, *Assam*, 17–8; Russell, *Cent. Prov.*, 10–11; Hadi, *United Prov.*, 76–7; Fawcett, *Bombay*, 25–9; Holder, *Madras*, 3; Fraser, *Burma*, 10; *Agri. Ledg.*, 1899, No. 12; *Journ. Chem. Soc.*, 1900, 362–3; 1902, 864; *Imp. Inst. Tech. Repts.*, 1903, 128, 131–2; Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 276; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 326.]

D.E.P., ii., 200.
Black Caraway.

CARUM BULBOCASTANUM, ***Koch.***; *Fl. Br. Ind.*, ii., 681; *Bunium Bulbocastanum, Linn.*; *Carum nigrum, Royle, Illust. Him. Bot.*, 229; *Rec. Bot. Surv. Ind.*, i., 154; *Paulus Ægineta* (Adams, transl.) iii., 74; UMBELLIFERÆ. Black Caraway, *siyah*, *shia*, *sájíra*, *shah-zerah*, *shiyah zirah*, *kala jerah* (*zerah*), *zirdu siah*, etc., also called *guniyun* in Kashmir and *umbhu* in Ladakh. These names seem for the most part to be modern adaptations, since the true *kálajíra* is the Black Cumin (***Nigella sativa***, see pp. 442, 811).

Habitat.

Black Caraway is a native of Baluchistan, Afghanistan, Kashmir, Lahaul, Chumba, etc., eastward to Garhwal and Kumaon, and westward to Quetta. It is mainly a weed of cultivated land, but is liable to prove dangerous in fields owing to the fondness of pigs for the root. It also exists truly wild on grassy slopes (at alt. 6,000 to 11,000 feet), whence the shepherds collect it as a valuable source of income; but it is nowhere cultivated. It is probably the *krishna-jiraka*, which Royle maintained was well known to the Hindus before the introduction of the European Caraway (***C. Carui***). [*Cf.* Lawrence, *Valley of Kashmir*, 67; Aitchison, *Bot. Afghan. Delimit. Comm.*, in *Trans. Linn. Soc.*, iii., 1.]

Grades of *Zerah.*

Adulteran
Singhu.

An inquiry instituted by the Reporter on Economic Products in response to a question put by the Indian Chambers of Commerce, resulted in the collection of specimens of *zerah* (*zíra*) from the chief towns of India as well as of the fruits (seeds) and plants from all known areas of supply. The fruits in every instance were found to be ***C. Bulbocastanum*** and not ***C. Carui*** (except when stated to be a foreign or imported drug). The examination showed, however, that other seeds are often used as adulterants or substitutes for black caraway. The adulterants were similar in shape, size and markings, but quite destitute of the characteristic aroma. For example, Mr. L. G. Smith, Forest Divisional Officer of Sambulpur, sent four samples from the local bazárs which were subsequently identified as (1) the true Caraway (*mita zerah*), most probably imported; (2) ***C. Bulbocastanum***, *sa-* or *shah-zerah*; (3) ***Vernonia anthelmintica***, *parbat-zerah*; and (4) ***Nigella sativa***, *kala-zerah*. The sample of black caraway was, however, not pure. Pure parcels were received from Yasin in Gilgit and from Hazara. From Kullu and Bashahr were furnished two qualities called "*zira*" and "*singhu.*" The latter was stated to be an adulterant. "*Zira*" proved to be ***C. Bulbocastanum***, and ultimately, through the assistance of Mr. J. H. Lace, then Assistant Inspector-General of Forests, the adulterant was recognised as ***Bupleurum falcatum***. Mr. Lace found the people gathering the seeds in Chamba; he secured a sample and corresponding botanical specimen, so that his material became an authentic type with which to compare the adulterants of commerical parcels. It was in consequence found that the ***Bupleurum*** was identical with the adulterant sent from most parts of India. Is this the *pseudo-bunium* alluded to by Paulus Ægineta which Adams suggested might be ***Pimpinella tenuis***? Mr. Lace says that ***Bupleurum*** is known locally as *banchak* or *bankok*, and that before it is mixed with the carum the fruits are coloured with a decoction of walnut bark. It is sold at 9 seers to the rupee, the true article being very much more expensive—say 3 seers to the rupee. Usually 5 seers of *banchak* are mixed with one seer of *zira*. The black caraway and its adulterant are therefore respectively the "*zira*" and "*singhu*" mentioned in the *Panjáb Forest Administration Reports* from 1894–1900 as obtained from the Kullu forests and sold, the former at Rs. 15 to Rs. 27½ per maund, the latter at Rs. 8. Sir Walter Lawrence says that the seeds of **Daucus Carota** are also used as an adulterant, but this cannot be done to any great extent since carrot-seed is not abundant and is also easily distinguishable from caraway, while the dyed **Bupleurum** can with difficulty be separated.

Uses.

The uses of this caraway, so far as can be ascertained, seem identical with those of **C. Carui**. From Bashahr large quantities of black caraway are conveyed annually to Rampur and thence distributed *viâ* Amritsar all over India. Amritsar also receives the Kashmir, Afghanistan and N. Himalayan supplies. Other emporia are Karachi and Cawnpore; the former obtains its supplies from Hazara and Baluchistan, the latter from Garhwal and Kumaon. The price at Cawnpore varies according to quality from Rs. 25 to Rs. 44 per maund of 52½ seers, but the consumption is very limited and the sales are usually in small parcels of ½ to 2 maunds. In addition to an Indian supply, Bombay imports from Persia. The wholesale price is said to be Rs. 8 per 37½ lb. (= Surat maund), and the retail price for cleaned fruit 8 annas per lb. [*Cf. Pharmacog. Ind.*, ii., 120; Kaye, *Settl. Rept. Baltistan Dist., Kashmir*, 1889, 16; Rivett, *Assess. Rept. Muzaffarabad, Kashmir*, 1899, 10, 12, 50, app. xxv.; *For. Admin. Repts. Pb.*, 1894–5 to 1901–2; *Rev. Working Plans, Pangi For., Chamba*, 1901, 2; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 119; etc., etc.]

Price.

D.E.P.,
ii., 196-8.
European
Caraway.

C. Carui, *Linn.*; *Fl. Br. Ind.*, ii., 680. The European Caraway, Carve, Kümmel, *zirah*, *karoya*, *karawya*. The vernacular names are in the main, of course, those given under the foregoing species, though sometimes to the name *zerah* is prefixed a description, as *mitha* (sweet), *vilayati* (foreign), or *safed* (white).

Uses. Medicine. Oil. Fodder.

As met with in India the fruits are mainly imported, but the plant is probably occasionally cultivated in gardens on the plains as a cold-season crop. The repeated though vague statements of its existence in India "wild and cultivated" seem likely to be due mainly to confusion with **C. Bulbocastanum**. There is, however, a fairly large import trade in the spice and it may be well to epitomise here a few of the chief uses of caraway, always premising that when such uses can be attributed to the Indian-grown caraway, the reference is in all probability to **C. Bulbocastanum**. The seed is employed both powdered and entire. In the former condition it is an important ingredient in curry powders; in the latter it is put into cakes, biscuits, etc. As a MEDICINE it is stimulant, carminative and astringent. But it is frequently used in flavouring cordials and certain preparations of Indian hemp (*bhang*). A valuable essential OIL, obtained from the fruits, is employed in medicine and as a perfume for soaps. The distilled oil is first mentioned in the price ordinances of Berlin for 1574 and in the *Dispensatorium Noricum* (1589). The two valuable constituents in the oil are *carvone* (formerly, *carvol*), which is the essential and odour-bearing body and possesses all the qualities of the drug in a pure form; and *carvene* or *limonene*, a by-product, not suitable for liqueurs but "can be satisfactorily employed instead of caraway oil in medium and cheap soaps" (Schimmel & Co., *Semi-Ann. Rept.*, April 1892, 12). The percentage of oil varies apparently according to cultivation and country of origin. Of the European sorts the Bavarian wild plant yields the highest percentage, 6·5 to 7, whilst the Russian stock yields only 3·2 per cent. The sp. gr. lies between 0·907 and 0·915; oils of lower sp. gr. rarely occur, and are less valuable as they contain less carvone. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 550–8.] A case of poisoning by caraway-seed presented symptoms similar to those induced by other essential oils. [*Cf. Ind. Med. Gaz.*, 1896, 145.] It may be added that caraway from which the oil has been expressed is dried in special apparatus and used as a CATTLE FOOD, being prized for its high percentage of crude protein (20 to 23·5 per cent.) and fat (14 to 16 per cent.). [*Cf. Paulus Ægineta* (Adams, transl.), iii., 158; *E.I.C. First Letter Book*, 201, 480; Bentham, *Comment. on Targioni-Tozzetti*, in *Journ. Hort. Soc.*, ix., 145; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 794.]

D.E.P., ii., 198-200.

Habitat.

C. copticum, *Benth.; Fl. Br. Ind.*, ii., 682; Cooke, *Fl. Pres. Bomb.*, i., 564; Prain, *Beng. Plants*, i., 536; Duthie, *Fl. Upper Gang. Plain*, i., 394. The Bishop's Weed, Lovage (of Indian writers), *ajowan, ajwain, ajwan, juvani* (*jurani*), *ajamo, chochara, owa, amam, omámi, omu*, etc., a herbaceous plant cultivated throughout India, especially in Bengal. It also grows in Egypt, Persia, and Afghanistan, and more recently was introduced into Europe.

History.

Cultivation.

Medicine Oil.

This is certainly not the "*ami*" or "*ammi*" of Dioscorides (as exemplified in the *Codex Vindob.*, 60, which is *Ammi Visnaga*), though that opinion has often been upheld. [*Cf. Pharmacog. Ind.*, ii., 116.] It would appear, however, to be *Ammi perpusillum*, of Lobel (*Stirp. Hist.*, 1576, 414). The fruits are certainly the *ajave* of Percival (1773). Pomet, physician to Louis XIV. of France (*Hist. Drugs* (Engl. ed.), 1712, 3, f. 5), observed that by far the best quality came from Alexandria and Crete. In India it is sown in October to November on ridges, the seed being dibbled every 6 inches; strong manures are deleterious but a liberal supply of water is necessary. The aromatic fruits are much in request for admixture in curries, etc., and in *pan supari*. The plant is referred to in the *Taleef Shereef* (Playfair, transl., 1833, 9) as astringent, aphrodisiac, vermifuge and diuretic. By distillation a WATER and an OIL are obtained, the percentage of the latter being about 3–4. The oil is given medicinally in cholera, colic, etc., being considered, like the fruits, antispasmodic, stimulant, tonic and carminative.

Omum-water : *Thymol.*

Fodder.

Omum-water is prepared and sold in most Indian bazárs. A crystalline substance or stearoptine separates from the oil and forms on the surface during distillation. This is sold as *ajwain-ka-phul* ("flowers of *ajowan*"), and is identical with *thymol*, which is the principal constituent (45 to 55 per cent.) of *ajowan*-oil and for which alone the fruits are distilled in Europe. It is prepared on a fairly extensive scale in Ujjain and other towns of Central India and was first made known to Europe by Dr. Stocks. The price is from Rs. 6 to Rs. 12 per lb. [*Cf. Rept. Cent. Indig. Drugs Comm.*, i., 125.] The value of *thymol* is mainly as an antiseptic, and very large orders have recently been received from Japan. The price in Europe varies with the character of the Indian season: during cholera and plague years it has been high (*e.g.* 22*s.* per kilo in 1901), but over-production has tended to keep prices low (*e.g.* 13*s.* 6*d.* in 1897, 13*s.* in 1903). Besides *thymol* certain hydrocarbons called *thymene* are obtained from *ajowan*-oil and used as a soap-perfume. A sample of the fresh plant itself cultivated at Miltitz (Saxony) yielded 0·12 per cent. oil, but the oil had only 1 per cent. of *thymol*. Of 8,641 cwt. of the fruit exported from Bombay in 1903, 8,443 cwt. went to Germany and the rest to America and Egypt. [*Cf.* Schimmel & Co., *Semi-Ann. Rept.*, Oct.–Nov., 1903, 104; Apr.–May, 1904, 130.] The distilled dried fruit contains 15 to 17 per cent. protein and 25 to 32 per cent. fat, thus making an excellent food for cattle. [*Cf.* Gildemeister and Hoffmann, *l.c.* 557; Craddock, *Rept. Land Rev. Settl., Nagpur*, 1890–5; Lawrence, *Valley of Kashmir*, 1895, 346; *Brit. Pharmacop.*, 1898, 335; White and Humphrey, *Pharmacop.*, 1901, 496, 553, etc.]

D.E.P., ii., 201–2.

Ajmud.

Food.

Medicine.

C. Roxburghianum, *Benth.*; Prain, *Beng. Plants*, i., 536; *ajmud, ajmot, randhuni, chanu, rajani*, etc.

This is extensively cultivated throughout India for the sake of its seeds, which are used in curries and to some extent for its leaves as a substitute for parsley. As a drug *ajmud* is regarded as carminative and stimulant and has the reputation of being specially useful in vomiting, dyspepsia, etc. (*Taleef Shereef* (Playfair, transl.), 1833, 8). It is probably only a cultivated form of ***C. stictocarpum**, var.* ***hebecarpa***, C. B. Clarke (*Fl. Br. Ind.*, ii., 681–2). [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 188; Fleming, *Ind. Med. Pl. and Drugs*, in *As. Res.*, 1810, xi., 157.]

D.E.P., ii., 206–8.

Sago-palm.

Habitat.

CARYOTA URENS, *Linn.*; *Fl. Br. Ind.*, vi., 422; Gamble, *Man. Ind. Timbs.*, 729; Prain, *Beng. Plants*, ii., 1093; Brandis, *Ind. Trees*, 654; Cooke, *Fl. Pres. Bomb.*, ii., 805–6; PALMEÆ. The Indian Sago-palm, Bastard-sago, *mari, bherawa, birlimhad, mhár-mardi, conda-panna, bhyni, shunda-pana, minbaw*, etc. A beautiful palm met with throughout the hotter parts of India from the Sikkim Himalaya and Assam to Ceylon and Singapore, distributed throughout tropical Asia and Malaya.

Fibre.

The Fibre.—The plant is mentioned by almost all the pre-Linnæan authors from Varro (116 B.C.) downwards. The chief commercial value of the palm lies in the fibrous cords or fibro-vascular bundles found naked at the base of the leaf-sheath and within the petioles, flowering stalks and even the stems as well. These constitute the strong *kittul* fibre of Ceylon and the *salopa* of Orissa, a fibre which also comes from Burma and Bombay. It is made into ropes, brushes, brooms, baskets, etc. As a brush fibre it was described in the *Treasury of Botany* (1866) and has been shipped from Ceylon to England since about 1860. Five or more strands, fastened together by special machinery, have moreover been found to make an excellent substitute for whalebone in corsets. Since the discovery that *kittul* fibre was not only equal but even superior to, because less brittle than, the Bahia *piassava* (the fibre of ***Attalea funifera***), several brush factories in India, it is believed, have begun to use it instead of bristles in hair-brushes, clothes-brushes, horse-brushes, etc. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1903-4, 29.] In this they are following the lead of European makers: Hannan (*Text. Fibres Comm.*, 1902, 155), for example, says that *kittul* is now in much request in Europe for brush-making and that some of the finest qualities have been adopted as substitutes for bristles. Jackson (*Comm. Bot. XIXth Cent.*, 1890, 142) observes that as much as forty (now fifty) years ago *kittul* fibre was exported to England for admixture with horse-hair (may it not have been ***Chamærops humilis***?). In the brush trade it is steeped in linseed-oil and thus made so pliable that it can be used either with or without bristles in making soft, long-handled brooms which are extremely durable and can be sold at about a third the price of ordinary hair-brooms. Dodge (*Useful Fibre Plants of the World*, 112-3) says it is also made up into machine brushes for polishing linen and cotton yarns, for cleaning scutched flax, brushing velvets, etc. Both in India and Ceylon fishing-lines are made from *kittul* fibre (Drury, *U. Proc. Ind.*) and strong wiry ropes capable of holding wild elephants are constructed of the fibre, while in Australia the leaves apparently are regarded as a good paper material. Lastly, the woolly substance or scurf scraped from the leaf-stalks is used in Burma for caulking boats. The quotations in London on April 20, 1901, were for *long quality*, 8½*d*. to 9*d*. per lb.; for No. 1, 6½*d*. to 7*d*.; No. 2, 2¾*d*. to 3¼*d*.; and No. 3, 1*d*; Ide & Christie (*Monthly Circ.*, Oct. 15, 1907) give the following returns of present date:—*Long*, 8*d*. to 9¾*d*.; No. 1, 6*d*. to 7¾*d*.; No. 2, 2*d*. to 3½*d*.; No. 3, 1*d*. to 1½*d*. Mr. J. C. Willis tells us (*Admin. Repts. Bot. Gard.*) that the exports from Ceylon have never exceeded those returned for the year 1898, viz. 3,794 cwt. The exports from India are unimportant.

Kittul or *Salopa* Fibre.

Brushes and Brooms.

Uses.

Price.

Sago: Sugar.

The Sago and Sugar.—Besides its fibres, ***Caryota*** yields from the interior of the stem a sago which is mentioned by Roxburgh (1832), by Robinson (*Desc. Acc. Assam*, 1841, 56) and by other writers as almost equal in quality to the best sago of commerce. As a matter of fact it would seem to be an inferior article, though quite wholesome (*Yearbook of Pharmacy*, 1903, 328). On the Malabar Coast and elsewhere it is made into bread or gruel and thus constitutes an important article of food with the poorer classes. The "cabbage" or terminal bud is edible, like that of most palms. Commelinus (Rheede, *Hort. Mal.*, i., 16, n.) remarks that, according to authors, the pulp of the fruit is bitter and irritates the tongue —a circumstance which doubtless suggested the specific name ***urens***. The fruit is certainly very pungent and insipid, but I cannot recollect having observed the tingling property just mentioned, though I have eaten it. Finally a toddy or juice is collected by "training" and "tapping" the spathes. This juice is either fermented and distilled into an alcoholic liquor or boiled down into a dark syrup which solidifies into jaggery or palm-sugar—an important product, especially in Bombay and Ceylon. Mr. A. M. Sawyer, writing of the "training" and "tapping" processes in North Travancore (*Ind. For.*, 1896, xxi., 134–8), says that at the end of the first five days of tapping the yield is about 4 quarts per day, increasing by degrees to 6, 8, and 12 quarts. In strong, healthy individuals even 18 or 20 quarts may be obtained at the end of the course. Sometimes, in an unusually prolific palm, three or even four spathes may be seen tapped at the same time, while others, in spite of the most careful training, yield no toddy whatever. An average-sized spathe is tapped in about four months, and all the spathes of one palm are exhausted in about two years. According to Roxburgh the best trees give as much as 100 pints in twenty-four hours. Further details may be found by reference to **Borassus** (pp. 170-1).

Toddy.

Sugar.

Yield.

The TIMBER is strong and durable, being much used for agricultural purposes, water-conduits, and for beams and rafters. Not infrequently it is cut into walking-sticks. The seeds are used as beads by the Muhammadans. [*Cf.* Rheede, *Hort. Mal.*, i., t. 11; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 150; Morris, *Comm. Fibres, Cantor Lect.*, 1895, 34; Lushington, in *Ind. For.*, 1899, 54–6; Sadebeck, *Kulturgew. der Deut. Kolon.*, 1899, 313; Jumelle, *Les Cult. Colon.* (*Aliment.*), 1901, 25–7; Wiesner *Die Rohst. des Pflanzenr.*, 1903, ii., 208, 411–2.]

CASSIA, *Linn.*: *Fl. Br. Ind.*, ii., 261–6; Gamble, *Man. Ind. Timbs.*, 1902, 271–5; Prain, *Beng. Plants*, 1903, i., 435–9; Duthie, *Fl. Upper Gang. Plain*, 1903, i., 290–6; Cooke, *Fl. Pres. Bomb.*, 1903, i., 417–27; Brandis, *Ind. Trees*, 253–5; LEGUMINOSÆ.

D.E.P., ii., 210-26.

A genus of herbs, shrubs or trees that contains in all about 380 species, mostly tropical, a few only being extra-tropical. India possesses some 18 indigenous species with three or four fairly plentiful introduced forms. They have all showy flowers but are mainly of value as medicines or as tans:—

C. Absus, *Linn.*; *cháksú, chimar* or *chinól, banar*, etc., a herb found fairly plentifully throughout India. The seeds are used in the treatment of ophthalmia and as a cathartic.

C. alata, *Linn.*; the *dádmardan* (= ringworm-killer), or *vilayati-* (or *shinnai*) *-agati* (the foreign ***Sesbania grandiflora***), is a small shrub found in gardens throughout India and supposed to have been introduced from the West Indies. The leaves rubbed up into a thin paste and mixed with vaseline constitute an effectual remedy for ringworm. [*Cf.* Fleming, *Ind. Med. Pl. and Drugs, As. Res.*, 1870, xi., 163; Bennett, *Wanderings N.-S. Wales*, 1834, i., 123.]

Ringworm.

C. Fistula, *Linn.*; the Indian Laburnam, the Purging Fistula, or *amaltás, alash, sundáli, sonali, báhavá, gurmála, konraik-kai*, etc. A moderate-sized tree of the Sub-Himalayan tracts ascending to 3,000 feet and common throughout the plains of India and Burma.

Indian urnam.

The bark is to some extent used both as a tanning material and a drug. The pulp of the fruit is regarded as a safe and useful purgative—one of the commonest of domestic medicines in India—but has the objection of not keeping well. Adams (Comment. in *Paulus Ægineta*, iii., 429–31) mentions that it was known to Serapion, Rhases, Mesua, Ebn Baithar, etc.—in fact to most of the early Arab writers, who speak of it as a purgative drug procured from India, Arabia and Egypt. It is also largely used in smoking mixtures to flavour the tobacco used by the Natives, especially in Bengal. [*Cf.* Mesua, *Op.* (ed. Marinus), 1562, 52; Garcia de Orta, *Coll.*, xiv.; also Clusius, *Hist. Arom.*, 1567, 136; also Comment. by Ball, in *Proc. Roy. Ir. Acad.*, 3rd ser., i., 400; Linschoten, *Voy. E.*

Medicine: Pulp of Fruit.

Smoking Mixtures.

Ind., 1598 (ed. Hakl. Soc.), ii., 121–2; Prosper Alpinus, *De Pl. Ægypti*, 1592, 3; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 361; Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 101–2; Ligon, *Hist. Barbados*, 1657, 68; Tavernier, *Travels*, 1676 (ed. Ball), i., 174, n.; ii., 20; *E.I.C. First Letter Book*, 200, 480; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 158.]

Jamaica Senna.

C. obovata, *Collad.*; sometimes called Country Senna, Jamaica Senna, Italian Senna. This is the *bhui-tarwar*, a plant common in many parts of India and occasionally to be seen in the bazárs as an inferior quality of Senna. [*Cf.* Greenish, *Pharm. Journ.*, 4th ser., ix., 470–1.]

Negro Coffee.

C. occidentalis, *Linn.*; the Negro Coffee or *kásóndi*, *kásundá*, *hikal*, *kálkashundá*, etc. An under-shrub abundant on waste land and roadsides throughout India, though probably originally introduced from America. The leaves, roots and seeds are medicinal. The seeds dried, then ground to powder, are used as a good substitute for coffee, and since they are antibilious are said to be often beneficial. [*Cf. Kew Bull.*, 1881, 34–5; *Yearbook of Pharmacy*, 1887, 175–6; *Pharmaceut. Journ.*, 1900, lxv., 439; Ridley, *Mal. Pl. Names*, 116; *Rev. des Cult. Colon.*, 1902, x., 63.]

Medicine.

Coffee Substitute.

C. Sophera, *Linn.*: the *káli-kasonda*, *jangli-takla*, *kál-kasondá*, *banar*—(the *kásamarda* or cough-destroyer)—a closely allied and often much confused plant with ***C. occidentalis***. It is cosmopolitan in the tropics and common throughout India. The bark, leaves and seeds are cathartic and the juice of the leaves viewed as a specific for ringworm. [*Cf.* Prosper Alpinus, *l.c.* 35.]

Ringworm.

Fœtid Cassia.

C. Tora, *Linn.*: the Fœtid Cassia or *chakundá*, *panerár*, *panwár*, *tarotá*, *kovaria*, *kowaria*, a gregarious annual under-shrub found everywhere in Bengal and throughout tropical India. This is in Sanskrit called *chakramarda* (= ringworm-destroyer), once more confirming the all but universal reputation of the species of Sennas. But in this particular plant a more or less new property has been attributed to the seeds, in that they are largely used along with indigo. For this purpose they are regularly sold to the dyers. They are also roasted, ground to a powder, and used in place of coffee. Mr. William Elborne of Owens College chemically investigated these seeds and came to the conclusion that their activity was due to "emodin, a substance closely allied to chrysophanic acid, in chemical characteristics, and considering the purpose for which the Natives of India use the plant, evidently in medicinal properties." Adams (Comment. in *Paulus Ægineta*, iii., 466) identifies this plant with the *kelkel* of the Arabs—a drug mentioned by Avicenna, Serapion, Rhases, etc. etc.

Ringworm.

Adjunct to Indigo.

D.E.P., ii., 212–5.

Tinnevelly Senna.

C. angustifolia, *Vahl.*; the Tinnevelly Senna of Indian commerce, perhaps best known by the following names:—*sanna-mukki*, *sená-makhi*, *Hindi-sanna*, *nilavirai*, etc.

Adams (Comment. in *Paulus Ægineta*, iii., 431–3) gives a most interesting sketch of the early knowledge in Senna. He says Serapion was undoubtedly the first author who describes the drug as an article of the Materia Medica. He, however, quotes still other writers, such as Isaac Ebn Amram and Abix. All the Arab physicians, in fact, extol the merits of senna in purging black or yellow bile and in acting as a cordial when mixed with suitable drugs, such as violets. The present species, as also the Alexandrian (***C. acutifolia***, *Delile*), were introduced to both Indian and European pharmacy through the Arabs. The former species (the only one grown in India) is fairly extensively produced in Tinnevelly, and recently its cultivation has been extended to Madura and Trichinopoly, districts of South India, and to Poona in Bombay. It is sown on red or black clay loams, fairly liberally ploughed and manured, the sowing being in May. Weeding has to be attended to, but irrigation is hardly if ever necessary. The season for collecting the leaves is June to December. The yield is said to be 1,000 lb. (2 *candies*) an acre, which allows a handsome margin for profit.

Cultivation.

Indian senna is either exported coastwise to Bombay and thence to foreign countries, or is consigned direct from Tuticorn. The drug is also imported by India from Arabia, where it is collected from the wild plant and accordingly often much adulterated. It would appear that about 5,000 cwt. are usually taken by India and again re-exported under the name of East Indian Senna or Moka or Aden Senna, and is thus no doubt the true *sanna* (*sona*) -*kokki* (*maki*) or *sanna hajazi*. For many years past, however, the imports from Arabia have been declining and the exports of Tinnevelly *senna* improving. The purity, high quality and low price of the Indian article place it in the front rank. In 1887–8 the total exports from India of locally grown senna came to 21,376 cwt., valued at Rs. 3,18,869. More recent figures are given by some writers, such as 5,000 candies annually from Tuticorin, but the data for an exact and detailed statement of the total trade are not available. Quite recently a new form of senna has appeared in the London markets from India. This has been shown by Barber to be *C. montana*, but as a drug it has been found inferior to *C. angustifolia*, and should therefore be discouraged. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1903–4, 30; Gibson, *Journ. Agri.-Hort. Soc. Ind.*, ii., 193; vi. (Select.), 128; *Pharmacog. Ind.*, 1890, i., 526–30; *Agri. Ledg.*, 1896, No. 29, 290; *Capital*, May 1902; *Pharm. Journ.*, 1901, 397.]

Aden Senna.

Exports.

C. auriculata, *Linn.*; the Tanner's Cassia, *tarwar*, *tarota*, *tangedu*, *tanghedi*, *tangadi*, *avala*, *avari*, etc. A tall shrub found plentifully in Central and South India as far north as Rajputana and also in some parts of Burma. It is common on dry stony hills and on black soils.

D.E.P., ii., 215-6.
Tanner's Cassia.

The bark is largely used in tanning and gives a buff-coloured leather. It has been remarked that Madras is favoured in the possession of this tanning material. But it is feared the discovery of the method of chrome tanning has even already given a totally new turn to the subject of Madras tanned or dressed skins and rendered the special advantage mentioned of comparatively little avail. (See **Hides**—Chrome Process, p. 637.) It has always, however, been contended that the raw skins of Madras are naturally well fitted for a high-class tannage. They possess some special properties much liked by the curriers into whose hands they eventually pass to be transformed into the morocco leather used for book-binding, furniture, carriage lining, and many other such purposes. Experts have, moreover, reported that the colour of leather prepared with this bark alone changes into murky brown, further that compared to its merits the price is too high (Rs. 20 a candy of 500 lb.). With a view to ascertaining more precise particulars as to supply, price, and property of this tanning bark, the Reporter on Economic Products to the Government of India issued a circular letter to Forest and other officers of India in which samples of the bark and full particulars were called for. The result was rather disappointing, and has been reviewed in *The Agricultural Ledger* (1896, No. 9). The Scientific Staff of the Imperial Institute also published some of their investigations with the bark (reprinted by Dunstan, *Imp. Inst. Tech. Repts.*, 1903, 184–5), from which it would appear that the samples examined gave extreme variations in amount of astringent principle and therefore of commercial value. Some time subsequently Hooper (*Agri. Ledg.*, 1902, No. 1, 27) pointed out that one source of diversity was in the age of the plant from which the bark had been collected. In young plants he found the bark to contain only 11·92 of tannin and 22·35 extract, while in old plants the corresponding figures were 20·12 of the former and 29·0 of the latter. In another part of his report (*l.c.* 3) he places

Merits.

Price.

Recent Investigations.

cassia bark as the fourth most valuable in a series exhibited by him, the cassia having 23 per cent. of tanning matter. Prof. Hummel, Yorkshire College, Leeds, found the tannin to be 20·5 per cent. On the other hand, Leather mentions only 15·5 per cent. of tannin, but a high accompaniment of soluble non-tannings. So also Prof. Procter (*Rept. Soc. Arts*, 1904), who places this bark as one of the Catechols, speaks of the "thoroughly unsatisfactory character of the *turwar* tannage, for the use of book-binding and upholstery," and asks whether there may not be other more desirable materials. These modern results and opinions would thus seem to assign a much lower position to the Tanner's Cassia than seems to be the belief in South India. By way of conclusion it may be mentioned that in the Northern Division of Madras the bark (*tanghedi*) or some *babul* gum is added to sesamum seed when it is to be pressed for its oil. It is said that this practice enhances the value of the cake (see p. 986).

Unsatisfactory Tannage.

Medicinal Uses.

The seeds, like those of ***C. Absus***, are valued as a local application in purulent ophthalmia. An infusion of the leaves is esteemed as a cooling medicine and as a substitute for tea. The leaves are also eaten as a green vegetable in times of famine. The shoots are largely utilised as Native tooth-brushes, and the root is spoken of as of great value in tempering iron metal (see **Acacia**, p. 5; and *cf.* Wiesner, *Die Rohst. des Pflanzenr.*, i., 716).

Tooth-brushes.

D.E.P., ii., 233-4.
Toon or Indian Mahogany.

CEDRELA TOONA, ***Roxb.***: *Fl. Br. Ind.*, i., 568-9; Gamble, *Man. Ind. Timbs.*, 157-9; Cooke, *Fl. Pres. Bomb.*, i., 217; Duthie, *Fl. Upper Gang. Plain*, i., 153; Brandis, *Ind. Trees*, 145; MELIACEÆ. The Toon or Indian Mahogany, Moulmein Cedar, *tún*, *lím*, *lúd*, *drawí*, *poma*, *tundú*, *thit-kado*, etc. A large, rapidly growing, deciduous tree, 50 to 60 or even 80 feet high and sometimes as much as 20 feet in girth It is met with chiefly near streams in the tropical Sub-Himalayan tracts, from the Indus eastwards to Sikkim and Assam; also at low elevations throughout Western and Southern India: less common in Eastern Bengal and Burma.

Timber.

This important Indian timber tree is extensively cultivated and often self-sown. It would appear to have been first described, so far as India is concerned, by Jones (*As. Res.*, 1795, iv., 281; also Fleming, *As. Res.*, 1810, xi., 163). The roots are surface-feeders, so that it ought not to be grown on the borders of fields. In the plains of the Panjáb the young plant must be protected against frost. The TIMBER is durable, not eaten by white ants, and not liable to warp. It is therefore much in demand for furniture and carvings, especially in Saharanpur (*Indian Art at Delhi*, 1903, 111), and in Bengal and Assam is constantly used for tea-boxes, hence its having become scarce. In Assam it was formerly much employed for boats and canoes, and in South India is very largely converted into cigar-boxes. It is exported from Burma as "Moulmein Cedar," and known under that name on the English market. Col. Seaton gives the cost of cutting and delivery as Rs. 44 per ton. Specimens sent to London from Dehra Dun in 1883 realised 4½*d.* per superficial foot, and in Malabar in 1902, ½-inch planking fetched Rs. 2 per cubic foot, ¾-inch planking was sold at Rs. 1-14-0, and 1-inch at Rs. 1-12-0. [*Cf. Ind. For.*, 1883, ix., 427; *Capital*, July 24, 1902, 118.]

Cigar-boxes.

"Moulmein Cedar."

Trade.

Medicine.

The bark is used, especially along with a powder of the nuts (seeds) of ***Cæsalpinia Bonducella***, as a tonic and antiperiodic in Native MEDICINE. The flowers afford a red and yellow DYE. [*Cf. Taleef Shereef* (Playfair, transl.), 1833, 61.] The seeds, young shoots, and leaves are given as FODDER to cattle.

Dye.

Fodder.

There are several other Indian forms, the properties of which are similar to those just detailed. The most important are ***C. microcarpa***, *C. DC.*, and ***C. serrata***, *Royle* (the *dál*, *dauri*, *soni*, etc.). The latter is particularly abundant below Simla and elsewhere in the N.W. Himalaya, where the timber is in considerable local demand, being employed for beams and sleepers, on

N.W. Himalayan Form.

sledge-roads, for wet-slides, bridges, hoops of sieves, etc. [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 154; *Ind. For.*, ii., 87–8; vii., 49–50; x., 246, etc.; Robinson, *Desc. Acc. Assam*, 1841, 41; *Pharmacog. Ind.*, i., 339; Greshoff, *Extra Bull., Kolon. Mus. Amsterdam*, 1896; Wiesner, *Die Rohst. des Pflanzenr.*, i., 79; ii., 94, 957.]

D.E.P., i., 235-7. Himalayan Cedar.

CEDRUS LIBANI, *Barrel.*, *var.* **Deodara**, *Hook.*, *f.*; *Fl. Br. Ind.*, v., 653; Ribbentrop, *Deodar*, in *Ind. For.*, 1899, xxv., app.; Gamble, *Man. Ind. Timbs.*, 710–6; Collett, *Fl. Sim.*, 487; Brandis, *Ind. Trees*, 1906, 691; CONIFERÆ. The Himalayan Cedar, *deodár*, *dedwár*, *diár*, *kelu*, *keori*, *kelon*, *kilar*, *giam*, *paludar*, *nakhtar*, etc. Dutt (*Mat. Med. Hind.*, 1900, 247, 296) gives it the Sanskrit name of *devadáru.*

Habitat.

A very large evergreen tree (often 250 feet) of the Western Himalaya, extending westwards to the mountains of Afghanistan and eastwards to the Dauli river in Kumaon; most common at 6,000 to 8,000 feet, but in the more eastern section of its area it ascends to 10,000 feet in altitude. Said to have been introduced into Great Britain about 1831, and is now cultivated to a considerable extent both in Europe and America. The closely allied species, the Cedar of Lebanon proper, was introduced, so Miller says (*Gard. Dict.*, 1731), into the Physic Garden of Chelsea about 1683. but it is now believed that it was actually being grown in England a few years before that date (1662–70). According to Bentham (*Notes on Targioni-Tozzetti, Journ. Hort. Soc.*, ix., 175), that cedar, although apparently well known to the Ancients as a valuable tree, had never been grown in Italy until carried from England to Pisa in 1787.

Cedar of Lebanon.

Cultivation.

The Deodar is usually though not always monœcious, and is roughly distinguishable from the Lebanon and Atlas cedars by its drooping branches and longer needles. Though gregarious it rarely forms pure forests, being found with blue pine, spruce, silver fir, oak, yew, poplar, horse-chestnut, etc. Gamble says that good seed years come about once in four or five years, and in suitable localities, where the seeds can get through the grass, weeds and moss of the surface covering, natural reproduction is very prolific. Artificial propagation also is not difficult, *deodár* being easily grown in nurseries, and with care successfully transplanted. Young plants suffer from waterlogging, and it is therefore best to transplant them from April to May. *Deodár* is probably at its best in good localities when about 12 feet in girth, but it can reach a much greater size, trees of 30 to 45 feet in girth, and 100 to 240 feet in height. It prefers a light soil and gneiss, granite or even limestone sub-soil; in the Himalaya it seeks the northern and western slopes, thus avoiding the rain, and in cultivation does not succeed either at Darjeeling or on the Nilgiri hills, where there is too much clay and too much rain.

Transplantation.

Timber. Weight. Durability.

This is the chief TIMBER of Northern India. It is light yellowish-brown, scented and moderately hard. When well seasoned its weight rarely exceeds 35 lb. per cubic foot. It is very durable as well as immune from white ants, hence is extensively used for railway sleepers. It is believed that the *deodár* timber of certain buildings in Kashmir and Kanáwar may be 600 to 800 years old. Accordingly it is held in considerable esteem for bridge-work and house-building (though its scent is by some regarded as too strong for interior fittings). It is rather brittle, however, and does not take paint nor varnish freely. In wood-carving, especially that of the Panjáb and Kashmir, *deodár* is of course pre-eminent. The Muhammadan and Sikh work are directly adapted to it, and the characteristic feature of old Kashmir wood-work may be said to have been the bold and effective *pinjra* or lattice panellings made of this wood. Further details as well as illustrations of *deodár*-carving may be found in *Indian Art at Delhi*, 1903 (103 and *seq.*), and the reader should also consult Lawrence's *Valley of Kashmir* (1895, 79–80) for further interesting details.

Wood-carving.

Oil.

An OIL (*kelon-ka-tel*), which resembles crude turpentine, is obtained from the wood, and is used in veterinary practice. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 279.] It is also employed by the men who float *deodár* logs down the rivers, to coat the inflated skins by the help of which they pass the rapids. In connection with the arrangements for the Delhi Durbar Exhibition, I observed that certain metallic objects kept in a box of *deodár* wood were beautifully varnished. On inquiry, I found this was due to the action of the oil. It would seem probable that this property may prove of much value. It should certainly be investigated. The aromatic wood (*bhadra-kashtha*) is employed in Native

Varnish.

Medicine.

MEDICINE, and the Arab physician Avicenna (about 1000 A.D., ii., 2, 213) said that it was called *sanúbar-el-hindi* and that it was useful in rheumatism, paralysis, etc. Ebn Baithar republishes the information given by Avicenna. [*Cf.* Celsius, *Hierob., etc.*, 1745, 74–105; Veitch, *Man. Conif.*, 1881, 134; *Tropische Agri.*, v., 258–61.]

Trade in Cedar.

Indian Supply.

Trade.—It is next to impossible to give a definite statement of the annual supply of this timber. It is floated down the rivers in the form of logs, sleepers, or scantlings. The oil which it contains prevents it getting waterlogged, so that comparatively speaking few pieces get irretrievably lost; nevertheless the obstacle that bars an extended use is the cost of transit from the forests to the markets. The *Forest Administration Reports* of the Panjáb, of the North-West Frontier Province, and of the United Provinces give particulars of the *deodár* removals from the forests owned or leased by Government, as also of the imports of that timber from Native States or foreign territory. The Statistical Department of the Government of India also gives particulars of the Trans-frontier traffic in which certain facts are given of imported timber. Comparing and analysing all these and such-like returns it may be affirmed that the annual supply obtained by the plains of India comes to approximately from 3 to 4 million cubic feet of this timber. The supplies come mainly from the forests of the Panjáb proper (Chamba, Kullu, Kangra, Bashahr, etc.), of Kashmir and Afghanistan, of Hazara, Kagan eastward to Jaunsar—the Tonse, Jumna, Bhagirathi, etc.

[*Cf. Paulus Ægineta* (Adams, Comment.), iii., 450; *Talcef Shereef* (Playfair, transl.), 1833, 83; McDonell, *Ind. For.*, 1885, xi., 213–20; Mian Moti Singh, *Ind. For.*, 1882, viii., 268; 1893, xix., 168–74; *Ind. For.*, 1898, xxiv., 61; *Pharmacog. Ind.*, iii., 380–2; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 147, etc.; McIntire, *Ann. Repts. For. Dept. Working Plans Pb. For.*, 1895; etc., etc.]

D.E.P., ii., 237–9. Black-oil.

CELASTRUS PANICULATA, *Willd.*; *Fl. Br. Ind.*, i., 617; *Pharmacog. Ind.*, i., 343–5; Gamble, *Man. Ind. Timbs.*, 1902, 175–6; Brandis, *Ind. Trees*, 1906, 162; CELASTRINEÆ. The Black-oil plant, *mál-kangni, mál-kungi, sankhu, kujúri, jiotish-mati*, etc. A scandent shrub of the outer Himalaya from the Jhelum to Assam, ascending to 4,000 feet, also of Eastern Bengal, Bihar, South India, Burma and Ceylon.

Oil. Medicine. *Oleum Nigrum.* Prices.

The seeds yield by expression a deep scarlet or yellow OIL, which is used in MEDICINE for external application. It is also burnt in lamps and employed in certain religious ceremonies, but its chief interest lies in the fact that by destructive distillation along with benzoin, cloves, nutmegs and mace is obtained the *oleum nigrum* of pharmacy, an empyreumatic fluid usefully employed, according to Dr. Herklot, in the treatment of *beri-beri*. In doses of 10 to 15 drops, black-oil is powerfully stimulant and diaphoretic. It is chiefly manufactured in the Northern Circars, the best quality being that of Vizagapatam and Ellore. The price of the seed is said to be about 2 annas per lb., and the oil about Rs. 20 per cwt. Moodeen Sheriff (*Mat. Med. Mad.*, 1891, 106–8), the *Taleef Shereef* (Playfair, transl., 1833, 148) and other writers say that the seeds are supposed to have the property of stimulating the intellect. The red seeds and the leaves are also employed in Native medicine. [*Cf.* Gamble, *Man. Ind. Timbs.*, 175–6; Cooke, *Fl. Pres. Bomb.*, i., 231; Duthie, *Fl. Upper Gang. Plain*, i., 158–9; Brandis, *Ind. Trees*, 162; etc.].

D.E.P., ii., 245. Cement Materials.

CEMENTS and materials used.—*Agri. Ledg.*, 1902, No. 5, 142–4; *Ind. Art at Delhi*, 1903, 95–6, 218; *Papers relating to Magnesia Cement* (a reprint of reports, letters, etc., dating from 1826 to 1837), issued by Madras Government.

Cements are commonly distinguished under five groups:—(*a*) calcareous; (*b*) gelatinous; (*c*) glutinous; (*d*) resinous; and (*e*) various materials. Since nearly all cements contain lime, the reader is referred to the article on that subject (pp. 695, 713). The following are the chief vegetable and animal substances employed as constituents in special cements, and mostly along with lime.

Adenanthera pavonina, *Linn.;* seeds (see p. 25).
Ægle Marmelos, *Corr.;* wild fruits (see p. 26).
Agave; sap (see p. 35).
Allium sativum, *Linn.;* fresh juice (see p. 58).
Borassus flabellifer, *Linn.;* juice (see p. 171).
Carthamus Oxyacantha, *Bieb.;* oil (see p. 276; also *cf. Agri. Ledg.*, 1904, No. 11).
Cocos nucifera, *Linn.;* jaggery and milk (see pp. 361, 929).
Commiphora Agallocha, *Engl.;* the gum-resin (see p. 400).
Gelatinous Cements; see **Isinglass** (p. 695).
Melanorrhœa usitata, *Wall.;* oleo-resin (see p. 779).
Oryza (glutinous rice); (see p. 826).
Sugar; *gúr* or jaggery used in *chunám* (see p. 956).
Triticum; gluten of wheat-flour (see p. 1088).
Typha angustata, *Chaub and Bory.;* the down from ripe fruits (see p. 777).

CERIOPS CANDOLLEANA, *Arn.;* also **C. Roxburghiana,** *Arn.*; *Fl. Br. Ind.*, ii., 436; Gamble, *Man. Ind. Timbs.*, 333; Prain, *Rec. Bot. Surv. Ind.*, ii., 306; Cooke, *Fl. Pres. Bomb.*, i., 473; *Agri. Ledg.*, 1902, No. 1., 32–4; Brandis, *Ind. Trees*, 304; RHIZOPHOREÆ. The Mangrove, *kirrari, kiri, chauri, gorán, madá, tengah, kabaing*, etc.

D.E.P., ii., 261.
Mangrove.

The vernacular name *gorán* or *garán* applies to both these plants, and in fact they are not economically distinguished. The former is a small evergreen tree of the muddy shores and tidal creeks of India, especially common in Sind; and the latter a large shrub of similar conditions in the Sundribans and the coast of Chittagong down to Tenasserim. The barks of both trees yield an important TAN. A sample of tannin-extract prepared in the Sundribans and examined in England in 1900 was not, however, much valued because of its dark colour. Prof. Trimble of the Philadelphia College of Pharmacy found 23·07 per cent. of tannin in the dry bark of a sample of ***C. Candolleana*** sent from Singapore, and 31·56 per cent. in a Bengal sample. Other Bengal specimens were found to yield on the dry bark 30·20 per cent. and 18·30 per cent. (Hooper); 17·77 per cent., 21·54 per cent., 13·23 per cent. (Dunstan). [For further details *cf. Imp. Inst. Tech. Repts.*, 1903, 186–90; *Agri. Ledg.*, *l.c.*] About ten to twelve thousand maunds of Mangrove Bark are sold annually for tan in the Calcutta market at about 10 annas per maund of dry bark. The extract is also used as a DYE to give a brownish-red colour to cloth, but especially a good black and purple in conjunction with indigo. In the Malaya the cloth is first dyed in Mangrove-extract, then dried, and subsequently dipped in indigo. [*Cf. Kew Bull.*, 1897, 91–2.] The whole plant is astringent: a decoction of the bark is applied to stop hæmorrhage, and on the African coast the young shoots are employed in the preparation of a substitute for quinine. The TIMBER of most of the species is hard and that of ***C. Candolleana*** is used for knees of boats. It is a superior fuel, and makes excellent charcoal.

Tan.
Sales.
Dye.
Medicine.
Timber.

CHENOPODIUM ALBUM, *Linn.; Fl. Br. Ind.*, v., 3; Duthie and Fuller, *Field and Garden Crops*, iii., 21; Cooke, *Fl. Pres. Bomb.*, ii., 501; CHENOPODIACEÆ. The White-goose-foot, *bathú-sag, chandan-betú, lúnak*, etc.

D.E.P., ii., 265–6.
Bathu.

There are various cultivated and wild forms of this ubiquitous plant, *e.g.* ***album*** proper (*chandan-betú*), ***viride*** (*bettú-shak*), ***purpureum*** (*lal-bethi*), etc. From the point of view of the present work the interest lies in the fairly extensive cultivation in the higher Western Himalaya as a food-grain and pot-herb. A sample of the seed sent from the Panjáb and examined at the Imperial Institute gave the following results:—water 8·3 per cent., albuminoids 18·4 per cent., starch 19·2 per cent., oil 21·1 per cent. The nutrient ratio was 1·377 and the nutrient value 86. Church (*Food-Grains of Ind.*, suppl., 8) says that "analysis amply confirms the Indian opinion of its highly nutritious character." The wild plant is regularly collected as a pot-herb and green vegetable. The leaves are rich in potash-salts. A decoction of the plant is used as an adjunct in indigo-dyeing and the seeds are employed medicinally (see **Vinegar**, p. 1110). [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 169, 194.]

Food
Medicine.

D.E.P., ii., 268-9.
Chittagong Wood.

CHICKRASSIA TABULARIS, *Adr. Juss.*; *Fl. Br. Ind.*, i., 568; Gamble, *Man. Ind. Timbs*, 156-7; Talbot, *List Trees, etc.*, 1902, 80; Cooke, *Fl. Pres. Bomb.*, i., 1903, 216-7; Brandis, *Ind. Trees*, 144; MELIACEÆ.

The Chittagong Wood or White Cedar, *chikrassi*, *lal-devdár*, *saiphra*, *saipropaon*, *pabba*, *aglay*, *agil*, *dalmara*, *yinma*, etc. A beautiful tree met with in the tropical forests from Sikkim to Chittagong and Burma, and from the Konkan and Deccan to Mysore, Malabar and Ceylon.

Timber.
Gum.
Dye.

It yields a beautiful yellowish-brown, richly veined satiny TIMBER, suitable for furniture, piano-cases, tables, etc. Gamble remarks that it deserves to be better known and exported from convenient localities like Chittagong, where it chances to be plentiful. It also yields a transparent yellow GUM, an astringent BARK (used medicinally), and flowers that afford both a red and yellow DYE. [*Cf. Pharmcog. Ind.*, 1890, i., 339; R.E.P., *Circ. Letter*, 1894-5, No. 25; *Prog. R.E.P. Office*, 1894-5, 1896-7, 1897-8, 1900-1; *Settl. Oper. Sagaing*, 1893-1900, 48.]

D.E.P., ii., 270-1.
Satin-wood.

CHLOROXYLON SWIETENIA, *DC.*; *Fl. Br. Ind.*, i., 569; Gamble, *Man. Ind. Timbs.*, 160-2; Talbot, *List Trees, etc.*, 81; Cooke, *Fl. Pres. Bomb.*, i., 1903, 217-8; Brandis, *Ind. Trees*, 146; MELIACEÆ.

Uses.
Timber.
Brush-backs.
Gum.
Dye.
Oil.
Fodder.

The Satin-wood, *bhera*, *bhira*, *billa*, *bella*, *billu*, *bilgu*, *madula*, *sengel*, *jirhul*, *sali*, *hurgalu*, *halda*, etc. A moderate-sized tree of Central and South India, also Ceylon. Is met with in the dry forests of the Circars, Konkan, Deccan and Karnátak, especially on poor soils, such as sand and laterite; common on the Satpuras and the sandstone formations of Kaladgi and Belgaum. Its most useful product is its TIMBER, the Satin-wood of commerce, which is largely exported from Ceylon and S. India ("Tamil Satin-wood"). It is in much demand for cabinet-work, the backs of brushes, picture frames, turnery (makes good stethoscopes), furniture, etc., and locally is utilised in house-building, carts and agricultural implements, but is not a good firewood, as it smokes too much. The tree also yields an amber-coloured GUM (of which little is known), a DYE, a wood-OIL and an astringent BARK, sometimes used medicinally, as also a paste made from the roots. Trees often destroyed on account of leaves being given as FODDER. [*Cf.* Forsyth, *Highlands Cent. Ind.*, 464; *Pharmacog. Ind.*, 1890, i., 338-9; Basu, *Agri. Lohardaga*, 134; Biscoe, *List Hyderabad Trees*, 1895, 5; *Ind. For.*, 1897, xxiii., 52; 1899, 181; *Cat. des Pl. Econ. Colon*, "*L'Hort. Colon.*," Brussels, 1900, 52; Wiesner, *Die Rohst. des Pflanzenr.*, ii., 953; *Imp. Inst. Tech. Repts.*, 1903, 248.]

D.E.P., ii., 272.
Babir.

CHRYSANTHEMUM CORONARIUM, *Linn.*; *Fl. Br. Ind.*, iii., 314; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 195; *Pharmcog. Ind.*, ii., 276-7; *Agri. Dept. Assam Bull.*, 1896, No. 2; *Ind. Pharmacol.*, 1897, 20-2; COMPOSITÆ.

Pot-herb.
Eaten in Formosa.

This cultivated little herb is of interest mainly because of the fact that from Dinajpur and Rangpur in Bengal, north-east to Assam, it is extensively eaten, and is number 15 in Buchanan-Hamilton's list of *sags* or pot-herbs. This fact seems to have escaped observation until re-discovered by myself while investigating the areas of successful cultivation of ***Boehmeria nivea***—China-grass. In my report on that subject, published in *The Agricultural Ledger* (1898, No. 15, 517-8), I pointed out that plants of the pea family become scarce, but that a peculiar series of pot-herbs take their places. Among these ***C. coronarium*** was found to hold a foremost position, being known as *babir* in North Bengal, *babui* in Assam, and *jalyniar* in the Khasia hills. It may now be added that after an inspection of the collections preserved in the Royal Herbarium, Kew, I am able to add that only one collector would appear to have previously recorded the observation of this plant being eaten. Speaking of Formosa, Walters calls it *tan-ei-tsai* and adds that it is a "herb much used by the Chinese as an article of food." Bretschneider (*Bot. Sin.*, 1892, pt. ii., 76) makes mention of two species of ***Chrysanthemum*** as known to the Chinese classics, the leaves of one of which are boiled into soup. This would appear to be called *ts'iu hua ku*, but in another part Bretschneider adds that he does not know the edible ***Chrysanthemum***. It is, however, remarkable that not a few of the special vegetables of the *rhea* fibre area of India should be more Chinese than Indian plants. For the medicinal and other uses of this plant the reader should consult the works cited in the opening sentence above.

Medicine.

D.E.P., ii., 274–84. Bengal Gram.

CICER ARIETINUM, *Linn.*; *Fl. Br. Ind.*, ii., 176; Duthie and Fuller, *Field and Garden Crops*, 1882, i., 33-6, pl. 8; *Agri. Ledg.*, 1895, No. 3, 37, 42; Mollison, *Textbook Ind. Agri.*, 1901, iii., 73-8; Prain, *Beng. Plants*, 1903, 365-6; Duthie, *Fl. Upper Gang. Plain*, 1903, 256; Cooke, *Fl. Pres. Bomb.*, i., 408; LEGUMINOSÆ. The Common or Bengal Gram; Chick-pea; *cicer* (Latin); *erebinthos, orobos, krios* (Greek); *ceci* (It.); *zisern, kirchern, ziser, kucherebs* (Germ.); *ciceren* (Belg.); *ciche, pois ciche, pois pechu, garvance* (Fr.); *gravancos, garbanzos* (Castilian); *cicerchas* (Sp.).

Chief European Names.

History.—Most of the modern European names, like the English chick-pea or chiche, have doubtless come from the same root as the Latin *cicer*. Others may be viewed as derived from the Greek name, *erebinthos*, or are descriptive of the shape of the seed (*krios*—the ram's head). Hehn (*Kulturpfl. und Haust.* 1894, 210 *et seq.*) identified *cicer* with the Greek *krios* (Dioscorides, ii., ch. 126). Apparently the earliest mention of the pulse in the literature of Europe occurs in Homer (*Iliad*, bk. 13, 589). Some centuries later Theophrastus (about 350 B.C.) assigned the word *erebinthos* definitely to the modern gram. Parched gram is mentioned by Horace as an article of food with the poor. Cicero took his cognomen from this pulse, as Fabius did from *faba*, also Piso and Lentulus from the pea and the lentil. Gram must, therefore, have been a common article of food with the poorer Greeks and Romans long before the Empire. The name "gram" comes from the Portuguese *grao* (*i.e.* grain), and was apparently a special appropriation made in India, because of its being in that country the most general grain given to horses. It is, of course, a pulse, not a grain, in the strict sense, but in South India, where cicer is but little cultivated, the name "horse gram" is given to ***Dolichos biflorus***, just in the same way that "green gram" denotes ***Phaseolus Mungo***. These pulses, cicer more especially, are frequently articles of cattle food, hence the expression "gram-fed" applied to the animals reared on them. Nikitin, a Russian traveller, who visited Western and Southern India in 1468, was impressed with the fact that in India horses were fed on peas. The old English words calavances, caravances, garavances and garvances are derived from the Spanish *garbanzos*, and were apparently given (and to some extent still are given) to several peas or beans largely used by mariners in place of fresh vegetables, hence very possibly the refrain of the mariners who "live on yellow peas." And these names survived till the beginning of the 19th century, for they occur in Act 54 of George III. (1814, ch. xxxvi.). For further particulars the reader should consult the article **Cajanus** (p. 199), also **Dolichos** (pp. 503–10) and **Vigna** (pp. 1107-8). [*Cf.* Cocks, *Diary*, 1620, ii., 311; Herbert, *Travels*, 1677, 333, 347; Fryer, *New Acc. E. Ind. and Pers.*, 1675, 21; Shelvocke, *Voyage*, 1719, 62; Hamilton, *New Acc. E. Ind.*, 1727, i., 393; Shaw, *Travels*, 1757, 140; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 249.]

History.

Gram-fed.

In Sanskrit this pulse is known as *chanaka* or *chennuka*, and in the vernaculars of India—*chana, chunna, chenna, chahna, chano, chania, sanna-galu* or *sanagalu, senagalu, chola*, etc. Occasionally other names are given to it, such as *bút, búta, harbara, kadli, kadalai, hariman-dhakam, kudoly kempa, kadale, kalapai*, etc. The first series are most frequently used in Northern, Central and Western India (down to Gujarat), while the second are specially prevalent in Eastern and Southern India from Bengal, Assam, Burma and west to the Maratha country, thence to the extreme south. In Arabic it is *humez*, in Kabyl *hammez*; in Egyptian *homos* or *omos* and in Persian *nakhúd*. Aitchison says that in Khorasan it is known as *nakhund*. De Candolle observes that south of the Caucasus it is known in Georgian as *nachuda*; in Turkish and Armenian as *nachius* or *nachunt*—names which De Candolle asks whether they may not be connected with the Sanskrit *chennaka*. In India the Arabic and Persian names are often used by Muhammadan writers. Thus in the *Ain-i-Akbari*, written 1590 (Blochmann, transl., i., 62), mention is made of *nukhúd dál* as a pulse, the price of which is given, and it is expressly stated not to be met with in Kashmir (Jarrett,

Indian Names.

Central Asiatic and Egyptian Names.

Sanskrit Literature.

transl., ii., 350). It is curious, however, that no mention is made of gram in the *Memoirs of Baber* (written about 1519 A.D.), so that it may fairly be inferred gram was not an important article of food with the army under the first great Mughal conqueror of India. Baber's silence regarding it may, however, have been a pure omission, or a consequence of its not having been a pulse new to him on his arrival in India, for it seems certain it was known to the people of India from a fairly remote period. By Hindus it is invariably described under its Sanskrit name, or some derivation from that. Susruta (*Ayur Veda* (Hessler, transl.), bk. i., ch. xx., 49), for example, alludes to it under the name of *hariman t'kata* as one of the specially wholesome articles of food. The name *hariman-dkakam* is very largely given to it by the present Tamil-speaking races. It is mentioned in the *Puranas* but apparently not in the *Institutes of Manu*. The vinegar made from the dew found on the leaves is referred to under the name *chana-kámla* by most of the Sanskrit medical writers.

Varieties.

Tibetan Plant.

Varieties.—While it is quite correct to say of it to-day, as it was when the *Ain-i-Akbari* was written, that Bengal gram is not cultivated to any extent in Kashmir, still there is a special form of the plant fairly extensively produced in the western temperate and alpine regions, between 9,000 and 15,000 feet in altitude, such as in Piti, Lahul, Kumaon and Tibet. This has been described by botanists as a distinct species under the name of ***C. soongaricum***, *Steph.* It bears the following vernacular names:—*tizhu*, *jawáne*, *banyarts*, *sárri* or *serri*—names apparently unconnected with those given to ***C. arietinum***; and since ***C. soongaricum*** is only met with in alpine Central Asia, it may be assumed to be there indigenous.

Kabul Gram.

Indian Special Races.

Never seen Wild.

So also a very special variety or distinct species is known as *kabuli* gram. This has been much talked of recently, and even experimentally grown in India, but with indifferent results. It is apparently a form peculiar to the country indicated by its name, though it is specially mentioned by Buchanan-Hamilton as met with by him in Dinajpur about 1809. It is thus a form that has been experimentally grown in India for a century or more. It is a much more robust plant than the ordinary gram, and has large white seeds. But in addition to these special Trans-frontier varieties, India itself has also several fairly distinct cultivated forms indicated by the colour of the pea, viz. red to yellow, brown, creamy white and almost black. But in no part of India or of its mountainous frontier has any botanist recorded the existence of wild or even naturalised representatives of any form of gram. They all exist purely and simply as cultivated plants, and on the plains are usually *rabi* crops. It seems highly probable, however, that the forms of chick-pea originated in the tract of country between the Caucasus and the Himalaya. And if that opinion be accepted they can be regarded as having been carried into Southern Europe, Persia and India in very ancient times. But it seems probable that at least one of the forms may have originated in Persia, so that the chick-pea may have been also indigenous to that country.

Cultivation. Area.

Distributi

Chief Gram-producing Area.

CULTIVATION.—Area.—During the five years ending March 1905, the average area shown in the volume of *Agricultural Statistics* for British India as devoted to this crop, comes to almost 11 million acres, and for the Native States a little under 2 million acres, so that an estimate of 12 million acres for the whole of India would be under rather than over the mark. The most important producing province is that of Agra, which during the period named possessed an average of 3¾ million acres, or say one-third of the Indian area. This is followed by Oudh (with 1½ million acres), by the Panjáb (which fluctuates very greatly, the area in 1899-1900 having been only 658,168 acres, and the very next year 3,405,121); by Bengal (with approximately one million acres); by Bombay, the Central Provinces and Mysore (with each normally a little under a million acres); by Gwalior (which has as a rule ½ million acres); by Berar, Madras and the North-West Frontier Province (with each about 150,000 acres); by Sind, Upper Burma, Alwar, Bharatpur and Kotah (with each about 70,000 to 100,000 acres); and lastly by all the other Provinces and Native States (which have each much smaller areas). It may thus be accepted that the upper basins of the Ganges and the Indus (which correspond with

Upper Bengal, the United Provinces and the Panjáb, also the adjacent portions of the Central Provinces, Central India and Rajputana) constitute the great gram-producing area of India. It has been repeatedly pointed out that a line drawn from Bombay to Patna would approximately divide India into two sections, the northern being the great gram area and the southern that in which gram is a very subordinate crop.

Production and Yield.

Highest in Chief Areas.

Production and Yield.—The yield of gram to the acre is annually reported by the various Governments and Administrations. It is shown to vary greatly according to suitability of soil and climate; the highest returns are in the provinces of chief production. In Bihar (the upper division of Bengal) the yield comes to 855 lb. per acre, *for land not irrigated;* in the United Provinces, 800 lb.; in the Panjáb, 634 lb.; while in Bombay, under similar conditions, the yield is only 410 lb. and in the North-West Frontier Province still less—406 lb. But *irrigated land* gives a higher yield than unirrigated: in Bombay as much as 1,200 lb. have been recorded; 950 lb. in the United Provinces; 835 lb. in the Panjáb, and 632 lb. in the North-West Frontier Province. Taking the nine chief producing provinces and accepting for a calculation of total production the mean of the published returns for 1901-2, on unirrigated cultivation, we arrive at the figure of 600 lb. as a possible safe average for all India. This, worked out to 10 million acres, or considerably under the present area, would show a total production of 53 million cwt. But that very large amount would in all probability be under rather than over India's actual supply, since this pulse is largely grown as a mixed crop and also as a garden vegetable, tracts not likely to be fully covered by its recorded acreage as a field crop.

Mean Yield.

Total Production.

It may be useful to take up the provinces one by one and exhibit the features of their gram-cultivation etc., that may be of interest:—

Bengal.

Bengal.—Gram requires the same land as wheat, barley, linseed and peas. It cannot be grown on sandy soils but requires a moderately heavy clay-loam. Five or six ploughings are given, commencing towards the close of the rains. About the latter half of October to the first week in November it is sown, and the crop ripens in February to March. The quantity of seed required ranges from 27 to 36 seers, more being needed when " broadcasted " than when " drill " sown. The plants are pulled up by the roots, made up into loads, and carried to the threshing-floor. The straw and the husks of the pods form excellent fodder. The yield is stated to be about 9·7 maunds (or, say, approximately 800 lb.). The cost of cultivation (according to the *Report of the Dumraon Experimental Farm for* 1902-3) has been put at Rs. 15-1-8, and the money value of the crop at Rs. 44-12-3 an acre. [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 174, 184; Basu, *Agri. Lohardaga*, 1890, 34; Barclay, *Fungal Disease, Agri. Ledg.*, 1895, No. 20, 381.]

Seasons.

Fodder.

Cost of Production.

Burma.

Burma.—Cultivation is important only in the upper districts. In Meiktila (*Settl. Rept.*, 1896-8, 10) it is said the land is prepared in October and the seed sown in November after having been soaked in water for a day and then sown broadcast. The crop ripens in February. The plants are tied up in bundles, dried in the sun, and threshed out either by sticks or by being trodden under foot by cattle. The harvest-time, all over the province, is from February to April. One basket of seed to the acre—the yield being 15 to 20 baskets. There are three groups of districts according to date of sowing, viz:—(1) September to October: Lower

Seasons.

Chief Districts: Range in Time.

Chindwin; (2) November: Shwebo, Sagaing, Mandalay, Pakokku, Myingyan, Meiktila, Magwe and Yamethin; (3) January: Minbu and Thayetmyo. The district with the greatest area appears to be Pakokku, followed by Minbu and Sagaing.

C. Prov.
Rotation.
Seasons.
Chief Districts.

Central Provinces.—In these provinces a rotation of *gram*, *massur* (*Lens*) or *butana* (*Pisum*) with wheat is much valued since the soil is thereby so improved that it does not require manure. This has been specially investigated at the Experimental Farm of Nagpur. [*Cf. Rept.* 1900–1, 10, 12; 1901–2, 9–10, 13; 1902–3, 8–9; 1903–4, 7, 8, 9; Voelcker, *Improv. Ind. Agri.*, 1893, 26–7, 234–6.] Gram is sown in October-November and harvested March-April. Two forms are mentioned as specially valued, a grey and a white. It suffers very much from falls in temperature or by hail-storms. In Narsinghpur, Hoshangabad, Betul and Raipur the crop is of special importance, and of Sambalpur it might be said gram is not cultivated. In a "Note on the Outturn of Land Under the Principal Crops," Sir J. B. Fuller has shown that the average outturn ranges from 377 to 860 lb. an acre, and that the standard there accepted was accordingly 600 lb.

U. Prov.
Forms grown.
Mixed Crop.

United Provinces.—Very little of importance has appeared regarding the gram of these provinces subsequent to the publication of the *Dictionary*. Duthie and Fuller observe that there are two main varieties grown—a large- and a small-grained plant. The former is reddish and the latter light-brown coloured. A black variety is not uncommon and there is also a very large white-grained form known as the *Kabuli*, which is, however, raised mainly as a curiosity. It resembles the Spanish form spoken of as *garbanzos*. Gram is largely grown as a mixed crop with wheat or barley. This would appear to have been the practice in Europe in classic times. Thus, for example, in the *Geoponicon* (a work attributed to the Emperor Constantine, A.D. 300) there occurs an interesting passage to the effect that *cicer* seeds should be soaked in warm water the day before they are sown, and "some add nitre." Then follows the observation that if an early crop be wanted it should be sown together with barley. The Indian practice is thus apparently a very ancient one.

Seasons.
Expansion.

The seasons of sowing and reaping are those already mentioned, viz. September to October and March to April or May. It is a dry crop mainly, and will grow on soils too poor for wheat. The outturn is on an average said to be 12 maunds (984 lb.), valued at Rs. 30, and the cost of cultivation Rs. 12 to 13. Within recent years the area under this crop has in many districts apparently been greatly expanded and at the expense evidently of wheat. It may be grown on a heavy clay to a rich loam, preferably the former. The tops of the shoots are nipped off with a view to make the plants bushy and thus increase the outturn.

Rajputana and Central India.

Rajputana and Central India.—The seasons of sowing and reaping are those already mentioned. Of Bharatpur it is estimated that the cost of cultivation comes to Rs. 6 to 10, the produce Rs. 20 to 10, and the net profit per acre would therefore be Rs. 14. It is said that the average yield in Ajmir is 300 lb. and in Merwara 446 lb. an acre.

Panjáb.
Sandy Soils.

Panjáb.—This pulse is by Baden-Powell, Stewart and Aitchison spoken of as largely cultivated throughout the province. Numerous passages regarding the methods of cultivation, seasons, yield, etc., will be found in the Settlement Reports and Gazetteers. One feature of interest may be specially noted, namely that the plant grown is said to succeed fairly

Mixed Crops. **Two Crops.** **Seasons.** **Not weeded.**

well on the sandy soils of many tracts of the province, especially as a mixed crop with wheat. Of Montgomery district it is observed there are both spring and autumn crops. It is not grown in the hill districts, a fact accounted for by some through the curious belief that the crop has a special affinity for lightning and is in consequence often destroyed by it. In most of the Panjáb districts, on the other hand, it is believed that manure is harmful to gram. It is sown in October and reaped in March and April. Christmas rains are beneficial, but if heavy rains fall in spring the crop is believed to be much injured. As a rule gram is not preceded by an autumn crop. The plants are "topped" by hand in order to cause them to branch. But like other *rabi* crops it is ordinarily not weeded. The chief districts are Ferozepore, Ludhiana and Hoshiarpur. [*Cf. Rept. Exp. Farm, Lyallpur*, 1901–2, 17–8.]

Bombay and Sind. **Chief Forms.** **Gujarat Grain.** **Production.** **Chief Crops.** **Rarely Mixed Crop.** **It kills Weeds.** **Seasons.** **Early Buds nipped off.** **Cost of Production.**

Bombay and Sind.—Mollison (*l.c.* iii., 73–8) gives a useful account of this pulse as cultivated in Bombay Presidency. He mentions four forms distinguished by the colour of the seed, namely black, dark red to brown, yellow to yellowish-red, and white to creamy. He remarks that the first three are often grown mixed but that the yellow of Gujarat is larger than that of the Deccan and when sold pure commands a higher price than the mixed pulse. The white is met with in Ahmednagar and may, Mollison thinks, be the *Kabuli* gram already repeatedly mentioned. The area of production depends on the extent of the rain that falls in September and October—when abundant, the area is increased. It is grown on the same class of soils as wheat, and the two crops are often interchangeable. Gram is a fairly important crop in the Deccan and Karnátak. It is grown in three ways: (*a*) as a dry crop in deep black soil, and is then usually the sole crop of the year; (*b*) as a dry second crop following rice, and occasionally (as in the Panch Mahals) as an ordinary dry crop after *kharif* maize; and (*c*) as an irrigated crop liberally manured and regularly watered. In Bombay gram is rarely grown as a mixed crop with wheat or barley, though it is often lined with lineseed or safflower. It is everywhere recognised as a valuable rotation, and in addition to nitrating the soil it forms such a dense surface herbage as to kill weeds and in that way improves the soil. The usual seed rate is about 40 to 50 lb. an acre. [*Cf. Crop Exper. Bomb.*, 1895–6, 6.] It is sown in October and November and ripens in February to March and April. Experiments performed at Poona Experimental Farm (1895, 10–11) confirmed the reputation of the advantage in nipping off the early green buds. But too frequent cultivation of gram on the same land causes liability to disease. Cold is harmful, frost fatal. Cloudy weather and heavy rains during the setting of the fruits are alike harmful. Many experiments have been performed (reported under *Crop Experiments*) to ascertain the cost of production and incidence of assessment. In 1896–7 two fields unirrigated were tested and gave the total value of produce as Rs. 17–12–0 for the one and Rs. 15–15–9 for the other, the assessment showing an incidence of 12·67 per cent. in the one and 16·45 in the other. These fairly represent the average of all results, though no calculation could be applicable to the whole Presidency since the conditions and necessities vary so greatly. [*The Experimental Farm Reports* teem with interesting particulars regarding this crop, and should be consulted.]

Berar.

Berar.—There is nothing of any material importance to add regarding this province to the particulars already recorded under the

Central Provinces and Bombay. It occupies about 24 per cent. of the area devoted to cold-weather crops and is most abundant in Basim, Buldana and Wun.

Madras.

Madras.—Bengal gram is an unimportant crop in Madras Presidency, its place being taken by the horse-gram (***Dolichos biflorus***). The manuals of North Arcot and Coimbatore districts contain, however, brief paragraphs regarding it.

Mysore.

Mysore.—The *Gazetteer* of this State will be found to give some useful particulars in connection with gram cultivation. It is grown on black soil, and as a second crop following *ragi*.

Uses of Gram.

Food and Fodder.

Parched Gram.

USES OF GRAM.—It would be beyond the scope of this article to afford details of every economic property of gram. The seed is extensively eaten both by men and cattle in every part of India except Madras. [*Cf.* Elliot, *Farinaceous Grains*, 1862, 294–5.] The pea is often parched and used in that form as diet, especially when cooking may be difficult or impossible. It is in this sense frequently of exceptional value to the Indian Army. The seeds are also steeped in water to remove the husks, then mashed up and boiled alone or with onions, etc. (and thus made into a thick soup), or the split peas may be cooked along with rice. Ground into flour gram is used in various ways, such as in the preparation of sweetmeats or biscuits. Although it is by far the most extensively consumed of all cattle foods in India, the results of the effort to introduce it into Europe as an article of horse food have not been encouraging. It would seem that when given in large quantity to animals not accustomed to it, poisonous effects have been observed. It has not, however, been placed beyond dispute that the grain used in Europe was pure gram. If adulterated with the pulse ***Lathyrus sativus*** the effects attributed to gram could be easily understood. [Consult the observations on this subject in the *D.E.P.*, ii., 279.]

Biscuits.

Poisonous Effects.

Pot-herb.

Fodder.

The young tops are largely collected and eaten as a POT-HERB. Moreover when sun-dried they may be preserved and used as required. As a ***FODDER***, gram-straw has the reputation of being inferior to that of other pulses owing to the amount of acid liquid (which contains oxalic, acetic and malic acids) found on the dew-besprinkled leaves. Still the stems, leaves and husks constitute important articles of Indian cattle food. They are specially valued for milch-cows, and are cut up and mixed with common straw.

Vinegar.

Medicine.

The property of the green plant in affording an acid liquid often called a VINEGAR has been known from the remotest antiquity. It is systematically collected by spreading clean cotton cloths over the growing plants at night and collecting from these the vinegar with which they have become charged. This is used both MEDICINALLY and in diet. One of the earliest European travellers who described this vinegar-dew was Dr. Hove, who explored the agriculture of Gujarat in 1787. [*Cf.* with Birdwood, Baden-Powell, Moodeen Sheriff, etc.; see also **Vinegar, p. 1109.**]

Nutrient Value.

Chemistry.—Church (*Food-Grains of Ind.*, 1886, 128; suppl., 1901, 12) gives the results of his examination of the husked peas:—The nutrient ratio he found to be as 1 : 3·3 and the nutrient value 84. Similarly ***C. soongaricum*** gave a nutrient ratio of 1 : 2·8 and the coagulable albuminoids amounted to 19·8 per cent., so that this form of the pulse is rather richer in albuminoids and in oil than are the seeds of the common gram. Leather has critically examined numerous samples of gram from all parts of India and has published in *The Agricultural Ledger* (1901, No. 10, 358–9; 1903, No. 7, 151, 155, 163) the results of his chemical investigations. Mr. Moreland has investigated the question of the extent to which gram may be used in the reclamation of upland *usar* soils. [*Cf. Agri. Ledg.*, 1901, No. 13, 424.]

Reclamation Crop.

Trade.

INDIAN TRADE IN GRAM.—In a previous paragraph the area has been accepted as approximately 12,000,000 acres and the yield something like 53,000,000 cwt. Gram is consumed very largely locally, so that the returns of foreign trade are comparatively of little value. Gram and millets are very much more the staples of Indian diet than are wheat, barley or rice. A study of the rise and fall in the prices of these grains affords, therefore, a surer indication of the cost of living and of the abundance or scarcity of food than can be learned from almost any other commodity (except perhaps the imports of copper metal). Were it possible to prepare a complete statement of the internal traffic in gram, it would be seen to what extent the resources of one province are drawn upon to supply the necessities of another. Unfortunately the record of internal transactions is very much less complete than the returns of articles received from or delivered to the shipping.

Staple Foods of India.

Indications of Famine.

Exports.

The total exports have rarely exceeded half a million cwt. In 1895–6 they were returned at 633,199 cwt., but the mean of the decade ending March 1904 comes to only 335,000 cwt., or 0·632 per cent. of the estimated total production. In 1906–7 they were 846,583 cwt., valued at Rs. 32,31,744. But of the exports a mean of about 35,000 cwt. goes from Madras, and should therefore be removed from the returns of *Cicer arietinum* and credited to those of horse-gram (*Dolichos biflorus*), so that this correction would very possibly bring the exports down to approximately ½ per cent. on production. A feature of interest in recent returns is the growing importance of Sind (Karachi) as an exporting centre. Still another fact may be added, namely that the major portion of the exports is commonly consigned to Mauritius, but sometimes to the United Kingdom; the traffic with the latter, however, seems subject to extreme fluctuations. By the coastwise trade 692,212 cwt. were carried in 1905–6, of which 370,165 cwt. went to Madras, about half from Bombay, and one-sixth each from Bengal, Sind and Burma. Of the rail-borne traffic nothing can be said, since gram is collectively returned with pulses.

½ per cent.

Karachi.

Mauritius.

Coastwise Traffic.

Prices.

Turning now to the available particulars regarding prices of gram. The years 1896 to 1901 have to be excluded from consideration as these were characterised all over India as years of scarcity and famine. But the effect of the increased facilities of railway communication may be said to have raised the price in centres where it was abnormally cheap and lowered the price where it was abnormally dear. Taking India as a whole the price seems to have been slightly increased, but not disproportionately with other commodities or with wages. In Assam gram sold in 1884 at 12·4 seers to the rupee (or say 1¼*d.* per 2 lb.), and in 1903 at 11·85 seers. In Bengal for the corresponding years it was 18·1 and 16·71; in the province of Agra 24·12 and 19·8; in Oudh 25·66 and 22·54; in Rajputana and Central India 21·36 and 18·31; in the Panjáb 32·22 and 21·06; in Sind and Baluchistan 20·49 and 15·76; in Bombay 18·08 and 14·2; in the Central Provinces 26·81 and 17·75; and in Berar 19·84 and 14·81. The mean of all these returns would be 21·9 in 1884 and 17·79 in 1903. That is to say one seer (2 lb.) would in the former year have cost 0·7306 of an anna (or of one penny), and in the latter year 0·8939. But the selection of single years for comparison, and the striking of means and averages in

Famine.

Equalised and raised

Averages often misleading.

these, can never be seriously advanced as evidence of value. For one thing it seems likely that the full effect of the years of famine was not effaced by 1903, and that better results would be shown in subsequent years. Local and accidental peculiarities are ignored by all such calculations.

Recent Returns.

Still, the figures given are of some interest. Later returns for 1905, which have since come to hand, show the following prices (seers to the rupee):—Eastern Bengal and Assam, 12·61; Bengal, 14·99; Agra, 17·34; Oudh, 17·21; Rajputana, 16·3; Central India, 15·71; Panjáb and N.W. Frontier, 20·63; Sind and Baluchistan, 15·5; Bombay, 13·59; Central Provinces, 16·49; and Berar, 15·14.

D.E.P., ii. 289–316. Peruvian Bark.

CINCHONA, *Linn.*: CINCHONA and PERUVIAN BARK, JESUITS' BARK; *ecorce de quinquina* (Fr.); *chinarinde* (Germ.); RUBIACEÆ. The species of *Cinchona* that yield QUININE are the most recently cultivated of all important plants. They are natives of the mountain forests of Bolivia, Peru, and Ecuador, and are chiefly met with in the valleys with an eastern trend from the great Andes, at altitudes between 3,000 and 9,000 feet and also in the western valleys of the central area.

History.

History.—Sir George King,—than whom few persons have a higher claim on the respect of the people of India—opens his *Manual on Cinchona Cultivation* with the following passages:—"Of the date and manner of the first discovery of the curative effects of Cinchona Bark, in malarious fevers, we know nothing.

Discovery.

And we are almost equally ignorant who the discoverers were, some writers claiming *that* merit for the aborigines of South America, while others assert, and with apparently greater accuracy, that not only did the Indians know nothing of the virtues of the bark, until these were pointed out by their conquerors the Spaniards, but that they still refuse to use the bark as a febrifuge. The introduction of this medicine to Europe is associated with the Countess of Chinchon, wife of a Spanish Viceroy of Peru, who having been cured by its use of an attack of fever, contracted while in that country, brought a quantity of the bark to Europe on her return from South America about the year 1639."

Dissemination.

Acquaintance with the virtue of the bark seems, however, to have been disseminated over the world with remarkable rapidity. It was discussed, extolled, and defended by Chiflet in 1653; by Badius in 1656; by Roland Sturm in 1659; by Morton in 1692; and by Pomet in 1694. It was known in London in 1655, and became officinal in the Pharmacopœdia in 1677. Fryer, who visited India in 1675, speaks of a "Brachmin" who gave a powder prepared from natural cinnabar in the cure of fever "which works as infallibly as the Peruvian Bark." This curiously interesting anecdote shows the rapidity with which the knowledge of this drug was carried across the globe. A century later it was fully described in an Indian work on Materia Medica under the name "Bark."

Early Indian Medical Writer.

This was written by Mir Muhammad Husain (*Makhzan-el-Adwiya*, 1770), who specially remarks that its virtues had been discovered by a sect of Christians called Jesuits. He adds that it bears the name of *kina-kina*. This is its name in the language of the Incas, and it gave origin to the French name *quinquina*, as given by Condamine originally, and to *china* in Spanish. The French obtained the bark in 1679, for it is recorded that Louis XIV. purchased a supply from an Englishman of the name of Talbor or Tabor. Talbor, like many of the Native doctors of India to-day, made his reputation and fortune through a fever mixture the chief ingredient of which was quinine.

Plants named Botanically.

Nothing, however, was known to the botanical world of the plant from which the medicinal bark was procured until 1739, when MM. La Condamine and Jussieu studied it, during an astronomical expedition to South America. The former sent a sample to Linnæus from Cajanuma, and in consequence in 1742 it was named ***Cinchona***, and in 1753 Linnæus established the species ***C. officinalis***. The plant is sometimes now known as *var.* ***Condaminea*** after its discoverer.

Grown in Paris.

The first living plant was shown in Europe in 1840, having been raised in Paris from Weddell's Bolivian seed, namely, ***C. Calisaya***. Thus, briefly, the medicinal bark was discovered in 1640; the plant was named a century later; and still another century later a specimen was grown in the Jardin des Plantes of Paris.

But if a lady was directly instrumental in the discovery of the great merits of this drug, a no less distinguished lady, the wife of a Viceroy of India (Lord Canning), was closely connected with its ultimate successful cultivation in India. Dr. Ainslie in 1813 lamented the fact that Cinchona was not grown in India. Dr. Royle in 1835 recommended that the Cinchona plants should be taken to India and grown on the Khasia and Nilgiri hills. About the same time Fritze, Miquel and other botanists advanced the claims of Java. No effort was, however, made for twenty years, not in fact until the heavy mortality through fever, during the Indian Mutiny, forced the subject into public attention. It was, moreover, well known that a reckless and selfish process of bark-collection was seriously endangering the world's future supplies of the drug. These circumstances combined to lay emphasis on the final recommendation of the Government of India, viz. that seed and plants should be procured for experimental cultivation in India. In consequence, Mr. (now Sir) Clements R. Markham was entrusted with the delicate and difficult task of procuring supplies. The subsequent incidents and final success which he attained are matters of history, and need not be here detailed. Sir Clements procured the services of several gentlemen whose names are all closely associated with his own, namely Spruce, Pritchett, Weir and Cross. The energetic co-operation of the Director of the Royal Gardens, Kew, guided and controlled all the subsequent efforts. Various consignments of plants and seeds were taken to Kew, and finally carried to India, certain plants having in due course been established on the Nilgiri hills. So far, however, the attempt to introduce the trees into Bengal had been a failure. On the other hand, the efforts of the Dutch botanists and chemists in the naturalisation of *C. Calisaya* and *C. Pahudiana* were crowned with complete success, and in consequence the noble Lady Canning discussed with Dr. Thomas Anderson, of the Royal Botanic Gardens, Calcutta, the desirability of a further effort being made to introduce the most useful species, if possible, from Java into the mountains of Bengal. Shortly after Lady Canning herself fell a victim to the scourge that she aimed at alleviating. Dr. Anderson was, however, deputed to Java, and he brought back with him a fairly large consignment of plants, some of which he left in Ceylon, others in the Nilgiri hills, and finally took a set to Calcutta Botanic Gardens and ultimately to Darjeeling. But many mistakes as to altitude, climate, method of treatment, best stock and the like, had to be corrected before a plantation could be established. Dr. Anderson lived, however, to see his labours brought to a satisfactory conclusion, and then, like the great lady who had sent him to Java, he died suddenly of malarial fever. But his laborious work was placed in the hands of a worthy successor—Sir George King. It would occupy many pages to narrate even the more striking features of the subsequent achievements. Anderson acclimatised the plants in Sikkim; King made their cultivation and the manufacture of quinine a commercial success. Suffice it, therefore, to say that a department has been so organised that the Government of India have long since discontinued to import quinine; the hospitals have been given a limitless supply of the finest quality at less per pound than a few years ago it sold at per ounce, and lastly, and by far the most remarkable accomplishment, packets of one dose are now sold in every Post Office, throughout the fever-stricken tracts, at the nominal cost of one farthing. This invaluable medicine has thus been brought to the very door of even the poorest peasant of India, and it is no wonder, therefore, that recurrent vital statistics mark year by year the steady conquest of India's greatest and direst scourge. Truly, therefore, may it be said of Lady Canning that she died to save others.

Java.

Indian Mutiny.

Sir Clements R. Markham.

Kew and India.

Java.

Anderson and King.

Successful Manufacture.

Post Office Packets.

Lady Canning.

[*Cf.* the following works, in amplification of the enumeration given in the *Dictionary*, may assist the reader to discover the fuller particulars which he may desire regarding the history, botany and cultivation of the Cinchona-yielding plants:—Lambert, *Genus Cinchona, etc., incl.* Vahl, *Dissert.*, 1797–1821; Bergen, *Monog. der China*, 1826; Weddell, *Hist. Nat. Des. Quinq.*, 1849; *Parliamentary Returns E. Ind. Cinchona Plantations*, 1852–75; Markham, *Peruvian Bark*, 1860 to 1880; also *Travels in Peru and India*, 1862, 483–520; Planchon, *Des Quinquinas*, 1864; Howard, *Quinology East Ind. Plantations*, 1869; Triana, *Nouv. Etud., Quinq.*, 1870; Campbell Walker, *Rept. Govt. Cinchona Plant.*, 1876; Cross, *Rept. C. condaminea in Ecuador*, 1861; also *Rept. Mission to S. America, etc.*, 1877–8; Bidie, *Cinchona Cult. in Br. Ind.*, 1879; Moens, *Kinacult. in Azië*, 1882; Gorkom, *Handbook Cinch. Cult.* (Jackson, transl.), 1883; Holmes, *C. Ledgeriana*, in *Journ. Linn. Soc.*, 1886, xxi., 374–80; Nicholls, *Textbook Trop.*

Agri., 1892, 221–9; Heuzé, *Les Pl. Indust.*, 1895, iv., 324–34; Holmes, *Cat. Med. Pl. in Mus. Pharm. Soc. Gt. Brit.*, 1896, 69–81; Lotsy, *Gouver, Kinaonderneming de Local. van het Alcaloid,* 1898; Broekhuizen, *De Kinacult.*, 1898; Reimers, *Les Quinquinas de Cult.*, 1900; Semler, *Trop. Agrik.*, 1900, ii., 242–77; Jumelle, *Les Cult. Colon.* (*Indust.*), 1901, 226–48; *Ann. Repts. Govt. Cinchona Plant. Beng. and Mad. up to* 1904; *Moral and Material Progress and Condition, India,* 206; etc., etc.]

Species, Varieties and Races.—There are about 30 to 40 species of *Cinchona*, and also numerous hybrids, varieties, and special cultivated races. Indeed so readily do the species cross and sport that it is impossible to grow two or more side by side and obtain from them uniformly pure seed. On this account grave doubts have been entertained regarding the specific values of many well-known forms. The commercial barks of to-day are obtained from about a dozen forms of which ***C. Calisaya*** and ***Ledgeriana*** are the most highly valued. To these would have to be added the special hybrid that appeared in Sikkim some few years ago, and is now spoken of as "the hybrid." The following brief abstract of the more important species may be useful:—

Calisaya Bark.

Sikkim.

Quinine.

C. Calisaya, *Weddell;* The CALISAYA BARK, YELLOW BARK, etc. A very variable species with a trunk, when full grown, twice as thick as a man's body. Largely grown in Sikkim, at moderate elevations (1,500 to 3,000 feet), and one of the most valuable of all forms, but is difficult to cultivate. The seed of this form was originally sent to Europe by Weddell. It was raised in Paris in 1851 and one plant was presented to the Dutch, by whom it was successfully conveyed to Java; and in 1873 Dr. van Gorkum reported that it was the chief form grown in Java—its most important alkaloid being QUININE. It was the species Markham specially charged himself with the task of securing in Bolivia and Peru. But it has many varieties, one of which is of very special merit, viz:—

Ledgeriana.

Java Stock.

High Percentage of Quinine.

Var. Ledgeriana.—The story of the origin of this form is very interesting. Mr. C. Ledger was travelling in South America on behalf of Australia in search of an animal resembling the alpaca sheep. His servant mentioned to him that it was difficult for collectors to procure the seed of the finest quality of cinchona because of the suspicion in which all persons interested in that drug were held. Accordingly Mr. Ledger said he would like to get some of the best seed, and in due time he was supplied. This was taken to Europe and sold. The major portion went to Java, but a small quantity found its way to the Nilgiri hills and a still smaller portion to Sikkim. The Java seed yielded 20,000 plants, the Nilgiri either failed to germinate or was neglected and lost, and the Sikkim grew and in time became the parent stock of the plants in the present Bengal plantations. In 1880 Mr. Gammie reported of Sikkim that he had 10 acres under ***Ledgeriana,*** and last year's report shows that out of the total 3,306,763 trees in the Government of Bengal's plantations, 2,566,057 were ***Ledgeriana.*** This plant was subsequently introduced into the South Indian plantations, and flourishes well in the Wynaad at 3,000 feet altitude. It yields a high percentage of quinine, and is deservedly the most popular of all stocks. But it is comparatively a small tree, and the yield of bark correspondingly less than with the larger forms. In Java some of the richest stocks are never allowed to seed, but are grafted on to other seedlings of this variety, and the high-yielding forms thus carefully developed and conserved. The same plant taken to India will, however, yield less than half the regular produce in Java.

Crown Bark.

C. officinalis, *Hook.;* the LOXA or CROWN BARK, the PALE BARK of commerce. This is a native of Ecuador and Peru, and with *C. succirubra* was the species assigned by Markham to his colleague Spruce to discover. It is grown at high elevations (above 7,000 feet) in the Nilgiris, Ceylon and Sikkim, but not extensively. It is a weak, straggling tree, attaining at most only 20 feet in height. Its cultivation in Sikkim has, however, been almost abandoned owing to the climate being too moist, but it is perhaps the most important of the species grown in the Nilgiri hills.

Red Bark.
South India.

C. succirubra, *Pavon;* the RED BARK. This is largely cultivated on the hills of South India at altitudes of from 4,500 to 6,000 feet; at higher altitudes the growth is too small to make its cultivation profitable. On the hills east of Toungoo in Burma and in some parts of the Satpura range of Central India it is grown, and also met with in the Government plantations of Sikkim, but is not popular, and is rapidly being replaced by *Ledgeriana.* It is a hardy plant with a bold sturdy stem. In rich and sheltered situations it grows to the height of 50 feet or more. The leaves are bright apple-green in colour, the plantation in consequence looking light and bright while one of *C. officinalis* looks dark and gloomy.

CULTIVATION.

Cultivation.
Climate and Soil.

Climate and Soil.—None of the medicinal species will stand frost, though they prefer a cool climate in which the contrasts between summer and winter and between day and night are not very great. At Ootacamund, about 7,500 feet above the sea, the minimum lowest temperature in the shade is about 49° and the maximum 69° F.; at Neddiwattum, 2,000 feet lower, the minimum is about 54° and the maximum 66° F. In the Rangbi Valley, Sikkim, at 3,332 feet in altitude the minimum may be given as 40° and the maximum at 88° F. This might be spoken of as ideal for *succirubra* but rather cold for *Calisaya.* A more congenial climate for both species would therefore be at an altitude of 2,500 feet. In the matter of humidity, the requirements of the cinchona were at first misunderstood. It has been found in the Nilgiris that all the species (particularly the red barks) withstand longer droughts than were thought possible. All the species assume a yellow tint during the rains, and in the Nilgiris all make their most vigorous growth during the time when sunshine and shower alternate. In Sikkim *succirubra* makes most progress during the latter half of the rains, but both on the Nilgiris and on the Himalaya the plants continue to grow for two months after the rains cease. The rainfall of Ootacamund is about 44 inches, that of Neddiwattum 105 inches per annum. The rainfall of the Sikkim Plantations of Rangbi is about 166 inches. The species are impatient of stagnant moisture, and therefore require an open gravelly subsoil, a sloping exposure, and a rich loam (especially so if of volcanic origin) to dry clay soil. Accordingly they succeed better on recently cleared forest than on old exposed grassy lands.

Temperature.

Humidity.

Rainfall.

Soil.

Propagation.
Seed: Cuttings: Layerings.
Transplanting.

Propagation.—They may be raised from seeds or multiplied by cuttings or layerings. The seeds may be sown in open beds of specially prepared soil shaded by a temporary roof, or in shallow boxes. The seeds should be sown somewhat thickly and sprinkled over with fine soil. They should be watered fairly freely, and in six weeks they will germinate. When the seedlings have got two or three pairs of leaves they should be transplanted

Close Planting.

in lines about 2 inches apart each way. When about 4 inches high, they should be again transplanted into lines 4 to 5 inches each way. When 9 to 10 inches high the seedlings will be ready for being placed in their permanent positions, and should be transplanted in wet and cloudy weather. They are then placed at distances of from 4 to 6 feet apart, according to species or local necessity. The red-bark may become a considerable tree, the crown-bark a medium tree, and the yellow-bark a bush or small tree. Wide planting would thus obviously be an error, especially for the two last-mentioned forms. In fairly close planting the ground is covered quickly; the plants in consequence shade the soil and check the growth of weeds, protect the surface roots, and produce straight stems that oppose a more compact and thus enduring face to destructive winds. If they are found to be too thick they can be thinned out, and an early crop of bark thus obtained.

Bark.

Thinning.

Highest Yields.

Best Age.

Bark Cultivation and Preservation.—The first crop, as already mentioned, is usually obtained by thinning out the plantation, when perhaps 25 per cent. may be at once uprooted and barked. This thinning out may with advantage be continued during the fifth or sixth years of growth, when perhaps not more than half the original plants may ultimately be left in the plantation. The bark is richest in alkaloid when the plant is about four years old. It remains at about the same level till the seventh year; after that period the proportion of alkali to bark slowly diminishes. The modern practice accordingly is to completely uproot a patch after the plants (more especially ***Calisaya***) have attained the age of 12 to 14 years. The roots are carefully washed and barked; in fact the richest of all barks are those taken from about a foot or a foot and a half on either side of the theoretical collar. Hence it may be said the roots are of much value, since they contain even more alkaloid than the stems and branches.

Barking.

The bark from both root and stem is then stripped off, care being taken to carry away none of the woody structure adhering. With this object rings are cut round at 18 inches apart, a longitudinal incision is then made between the rings, and the bark thus removed in sections. It is dried in the subdued sun or shade for two or three days, and when quite dry is stored and packed and exported or conveyed to the factory.

Lopping.

With standing trees the bark may be obtained by one or other of the following methods:—(*a*) ***Lopping*** off branches, and obtaining the bark from these in the way already mentioned.

Coppicing.

(*b*) ***Coppicing.***—That is to say, trees when about six years old are cut down to the ground and barked. Fresh shoots spring up, one or two of which are allowed to grow, and these in time are again coppiced when sufficiently thick to afford useful bark. This method is most suitable for crown-bark.

Shaving.

(*c*) ***Shaving.***—This is a Java system. The bark is shaved off as near to the cambium layer as possible but without injuring it. This is best done by an instrument that resembles an ordinary spokeshave. The bark is renewed quickly unless when the cambium has been interfered with. The best plan is to shave off two strips on opposite sides of the stem, since in this way the tree is not materially injured. In dry weather it may be necessary to protect the wound by tying dry grass over it, but if close planting be pursued this will not be necessary.

Stripping and Mossing.

(*d*) ***Stripping and Mossing.***—This is really only a special modification of the shaving process. The bark is cut off in alternate bands or strips of 1½ to 2 inches in breadth, the whole stem being afterwards swathed in moss. When the wounds have been barked over, the intervening bands are stripped off and the mossing renewed. This was invented by McIvor in the Nilgiri hills, and is now abandoned in favour of the shaving system.

Shaving *versus* Coppicing.

All renewed bark, whether produced by shaving or mossing, is found richer in alkaloid than the original bark, so that the shaving process, being less troublesome and the cambium less liable to injury, has come into fairly general practice; and moreover the yield of alkaloid is higher by this than by any other method. It may, however, be added that the renewed bark is never so thick as the original, and therefore less in weight. It becomes accordingly a question whether coppicing is not, after all, the most profitable system. It is certainly the least troublesome, and if followed by systematic uprooting and fallowing of the land, allows of complete renovation.

Drying and Packing.

Drying and Packing.—As already indicated, the bark, by whatever process procured, should be dried gradually. In rainy weather this may have to be accomplished in specially prepared drying-sheds, or the bark may be quickly dried in special evaporators. Sun-drying is the best. According to the age of the plant, method of collection and drying, there are various grades of each botanical bark. Thus, for example, *root-bark*, *quill-bark* (that from the branches), *shavings*, and lastly *flat-bark* (that from large stems).

Qualities of Bark.

Effects of Heat.

Exposure to a high temperature or to prolonged action of direct sun's rays injures the bark. It is best, therefore, to bark the trees in dry weather, to dry slowly, to turn the pieces repeatedly, and to take every precaution to prevent moulding or fermentation. Once properly dried, the bark will keep indefinitely, or at all events for many months, without deterioration; but in drying, the loss in weight depends on the species and method of treatment—the average is usually from 70 to 76 per cent. of the fresh weight.

Manufacture.

PRODUCTION AND MANUFACTURE.—To trace, even in the very briefest manner possible, the history of the discovery and the development of all the methods of manufacture that exist, would take many pages and involve a complete review of the chemistry of cinchona. [*Cf. Journ. Pharmaceut. Soc. Gt. Brit.; Journ. Soc. Chem. Indust.; Chemist and Druggist; British and Colonial Druggist; Pharmacog. Ind.*, etc., etc.] In 1888 the Government of India published for general information the final results of the experiments conducted by Sir George King and Mr. G. A. Gammie that may be said briefly to have resulted in the perfecting of the oil process of manufacture now very largely pursued. This may be said to mark the turning-point of the Indian industry from that of experiment to commercial attainment.

Indian Experience.

Production.

Area.—The area under this crop has been seriously curtailed. In 1897–8 an official publication reviewed the then available information. It was ascertained that there were 4,346 acres under the crop, of which 68 per cent. were situated in Southern India. The Bengal portion was 1,394 acres, of which only 10 acres were not owned by Government. In the Madras Presidency, on the other hand, the State plantations represented but 800 acres out of the total 2,952. But during the twelve years ending 1897–8 the area had fallen from 14,491 to 6,833 acres, and there is reason to believe that a temporary expansion has since taken place. This

Private and Government.

Decreased Area.

Fall in Price. Official Statistics. Trade.

remarkable decrease is believed to represent the discontinuance and adjustment of Indian production as a private venture. The reasons usually given for this are the fall in price of quinine, the greater margin of profit in tea, coffee and other commodities, and the more successful production in Java and other countries. According to the *Agricultural Statistics*, the area in 1898–9 was 6,192 acres; in 1899–1900, 5,006 acres; in 1900–1, 4,903 acres; in 1901–2, 4,930 acres; in 1902–3, 5,260 acres; in 1903–4, 5,014 acres; and in 1905–6, 5,309 acres. Of these areas Bengal had an average of 1,400 acres, of which 70 to 100 acres were private plantations. The area in 1904–5 was 5,269 acres (1,800 acres in Bengal, 3,293 in Madras, and 176 in Coorg). Indirectly certain additional particulars may be learned from the study of the exports to foreign countries. For a good few years past these have fluctuated severely, but manifested a steady decline which more or less corresponds with the curtailment of private interests. In 1899–1900 the exports of bark stood at 3,290,236 lb., but in 1906–7 they had fallen to 494,587 lb., and were made exclusively from South India.

Bengal Factory. Number of Trees. Expansion. Pice Packets.

Government Plantations and Factories.—Turning now to the reports of the Government plantations and quinine factories, of which we possess more or less definite information, we learn that in Bengal during 1903–4, according to the report issued by Lt.-Col. D. Prain, the estimated total acreage is not stated, but the expansion is shown to have come to approximately 180 acres. It seems likely that private interests have not, however, materially increased, and that therefore the total area returned by Government in the volume of the statistics of crops may be accepted as representing the Government plantations, viz. 1,400 acres. If doubt exists as to the exact area the number of trees grown is systematically given, and from that a more trustworthy conclusion may after all be drawn. In 1903–4 there were 3,306,763 trees, of which 2,566,057 were *Ledgeriana*, 257,602 *succirubra*, 2,130 *officinalis*, while 463,075 were Hybrid No. I., and 17,899 were Hybrid No. 2. These figures show an expansion on the corresponding numbers for the previous year that comes to 291,163 trees (practically the equivalent of the expansion of 180 acres). The crop taken from the plantations came to 316,757 lb. of dry bark, but to meet the necessities of the factory 461,467 lb. of bark had to be purchased and mostly imported from Madras. The manufactured products of the year came to 16,404 lb., which consisted of sulphate of quinine (12,314), sulphate of cinchonidine (290), and cinchona febrifuge (3,800). The Bengal factory by official arrangement supplies Bengal, Assam and the Panjáb. The issues from the factory were quinine 12,021 lb., which included an increase during the year in the form of pice packets that amounted to 1,500 lb. The sales of cinchona febrifuge manifested a decrease of 976 lb., and the final working of the Department showed a net surplus of Rs. 66,320.

Recent Returns.

In the latest report for 1906–7, by Capt. A. T. Gage, which has come to hand since the above was written, it is stated that "the number of Cinchona trees of all sorts on the permanent plantations on March 31, 1907, was 3,698,777. Of this number 3,006,847 were *Cinchona Ledgeriana*, there being 1,770,521 on Mungpoo Plantation and 1,236,326 on Munsong Plantation. The remainder consisted of *Cinchona succirubra* and 77,283 of Hybrid No. 2—both mostly on Mungpoo Plantation." "The amount of bark yielded by both plantations was 429,557 lb., of which

376,025 lb. were *Cinchona Ledgeriana* bark, and the greater part of the remainder Hybrid No. 1 bark. Of the *Ledgeriana* bark, Mungpoo supplies 286,994 lb. and Munsong 89,031 lb." "The total quantity of bark worked up in the factory was 798,500 lb., made up of 513,180 lb. of *Ledgeriana* and 85,320 lb. of Hybrid No. 1. The output of Quinine Sulphate amounted to 16,065 lb. 4 oz., being an increase of 287 lb. 8 oz. on last year's output." The manufacture of cinchona febrifuge was suspended for part of the year and only 2,652 lb. were produced; no cinchonidine sulphate was manufactured, so that the total output of the factory was 18,717 lb. 4 oz. The average yield of quinine sulphate in the bark supplied to the factory was 2·68 per cent. Output of Quinine.

Madras Factory. Correspondingly the records of the Madras plantations and factory may be reviewed. The chief districts are the Nilgiri hills, Malabar, Travancore, Mysore and Coorg—but mainly the Nilgiris. Mr. Standen in his Annual Report for 1903–4 speaks of the old plantations having consisted of 832 acres and the new extensions as being 440 acres, a total of 1,272 acres. The production was only 116,289 lb. of bark as against 166,220 lb. in 1901–2, the difference being due to the policy of restraint in cropping during years of cheap private supply. But to meet the demands of the factory 431,185 lb. of bark had to be purchased from private producers. Bark purchased. The issues from the factory during the year were 15,040 lb. of quinine and 3,359 lb. of febrifuge. The supplies go to Madras and Mysore, Bombay, the Central Provinces, United Provinces, Rajputana and Central India, Hyderabad and Burma. The net profit of the department during the year was Rs. 83,340, a highly satisfactory state of affairs. Profits.

Net Results.—Practically, therefore, the Government of India's endeavours to acclimatise the cinchona plant may be said to come to this; the annual imports of the drug on behalf of the Government have been discontinued; India has been given a liberal supply of an invaluable drug at a remarkably low price; the working of the two sets of plantations and factories have given lucrative employment to a fair number of persons; lastly a net profit has been secured of Rs. 1,39,660 a year (say £9,310)—a truly creditable record. Practical Results. Recently the Government of India took into consideration the desirability of lowering the price of the packets sold at the post offices. It has been resolved that in future seven in place of five grains shall be given for one pice (one farthing). This has had the immediate effect of increasing the demand, and the future must of necessity witness a considerable expansion both of production and manufacture. Increased Demands.

TRADE.—It has been shown that the two Government factories in 1903–4 supplied between them 27,061 lb. of quinine to the hospitals, jails, post offices, etc., of India. In addition there was imported during the preceding five years an annual average of 54,000 lb. of quinine—chiefly from the United Kingdom and mainly into Bengal. In 1904–5 the imports were 68,648 lb., valued at Rs. 6,92,329, and in 1906–7, the latest year available, 71,237 lb., valued at Rs. 6,28,430. Imports. These are significant figures. They would seem to show that a successful industry might be organised by private enterprise, to meet the demands that create these imports. But it has to be recollected that in Java both the climate and soil are peculiarly favourable to the cultivation of cinchonas with a high percentage of quinine. Java will, therefore, always hold its own against India, and thus lessen the prosperity of any resuscitated industry. Javan Control. The indents on Government production have for years been steadily increasing, so that the plantations hardly do more than meet half the requirements of the Government factories; but it is probable the extensions that have been made will reduce the demand on private production. In spite of past failures, however, there would seem every hope that the cultivation of the most approved varieties might be made a profitable adjunct to tea, especially in the Darjeeling district. The difficulty is to obtain suitable land in desirable situations. There would also seem every likelihood that private manufacturing establishments, to use up the bark presently being exported, might prove successful. India's demand for quinine is great and increasing. Exports. The exports of bark were 3,290,236 lb. in 1889–1900; 2,753,858 lb. in 1900–1; 1,917,259 lb. in 1901-2; 1,579,498 lb. in 1902–3; 1,108,527 lb. in 1903–4; 1,177,394 lb. in 1904–5; and 494,587 lb. in 1906–7. These went almost exclusively from South India and to the United Kingdom. There are said to be in the world 18 quinine factories: 5 in France; 3 in England; 2 in Germany; 1 in Holland; 4 in America; 2 in India, and 1 in Java. World's Demands. But the modern trade centres mainly in Amsterdam. The world's demands for bark average from 14 to 18 million pounds.

D.E.P., ii., 317–26. **CINNAMOMUM,** ***Blume*****:** *Fl. Br. Ind.*, v., 128-36; *Pharmacog. Ind.*, iii., 199–210; Gamble, *Man. Ind. Timbs.*, 560–4; Prain, *Beng. Plants*, ii., 898; Brandis, *Ind. Trees*, 532–4; LAURACEÆ. Gamble observes that there are about 24 species placed under this genus and divided into two subgenera, MALABATHRUM taking 20 and CAMPHORA 4 species. It is not intended in this work to discuss at all fully more than two of these, viz. ***C. Tamala*** and ***C. zeylanicum.*** A third species, ***C. Camphora,*** will, however, be found separately dealt with under **Camphor** (p. 245).

Cassia Lignea. **Cinnamomum Cassia,** *Bl.*—This is the plant which in China is regarded as affording the finest quality of CASSIA LIGNEA—the true Cassia bark of the ancients. A sample of this bark was lately sent from the Patkai mountains, on the frontier of Assam, accompanied by fairly satisfactory botanical specimens. These were critically examined by Prain and myself and compared with authenticated specimens of the Chinese plant. There would, therefore, seem no doubt that the best qualities of Assam Cassia are the true CASSIA LIGNEA of commerce. It is possible that to this circumstance is due the improved trade in the Assam bark. [*Cf.* Thiselton-Dyer in *Journ. Linn. Soc.*, xx., 19-24; *Pharmacog. Ind.*, iii., 203–8; Gildemeister and Hoffmann, *Volatile Oils*, 382–91.]

Nepal Sassafras. **C. glanduliferum,** *Meissn.*; the Nepal Sassafras or Nepal Camphor-wood (the *malligiri*), is a large tree of the Southern Himalaya, from Kumaon eastwards to Assam, but especially so in Nepal. Its wood is strongly camphor-scented. It is very readily confused with ***C. cecicodaphne***, *Meissn.* (the *rohu*, *gun-serai*, *gún-droi*), a tree of the Eastern Himalaya, especially Darjeeling and Assam. Still further to the east ***C. Parthenoxylon*** is the Martaban Camphor-wood, and apparently also the Camphor-wood of the Malaya. Camphor-wood is used for boxes, furniture and even canoes, but is brittle.

Camphor-wood. **C. iners,** *Reinw.*; the *hmanthin* of Burma. This large tree is met with in the forests of Tenasserim and the Malay Peninsula. Its timber is one of the camphor-woods of commerce, and according to some writers the bark is one of the qualities of CASSIA LIGNEA. It would seem probable that much of the economic information given in the *Dictionary* and in other works on Indian economic botany, under this species, should be transferred to the ***C. zeylanicum*** of Western and Southern India. [*Cf.* Holmes, *Pharm. Soc. Mus. Rept.*, 1895–1902, 54.]

Karua. **C. macrocarpum,** *Hook., f.*: *Fl. Br. Ind.*, v., 133; *Carua*, *Ham.*, *Trans. Linn. Soc.*, xiii., 550-5. This is a small tree of N. Kanara and seems to be the plant described by Rheede (*Hort. Mal.*, 1686, i., 107-10, t. 57) as *karua*, *bahena* and *tiqui* (*tikhi*), and which he said differed from ***C. zeylanicum*** of that region by having large fruits, and by its flowering in January instead of July.

Oil.

Kala-nagkesar.

Malabar Cassia

From the root bark, as also the leaves, Rheede remarks, an oil was prepared and used as an external medicine. It would seem probable also that this plant affords the *kala-nagkesar* or immature fruits that are sent to Bombay from the Malabar forests. Clusius in his version of Garcia de Orta (*Hist. Exot. Pl.*, 1605, 178) gives a picture of *tamalapatra*, in which he shows unripe flower-buds that closely correspond with the *kala-nagkesar* of modern commerce. They were probably in ancient times employed in flavouring the wine known as Hippocras. It is hardly necessary to give the warning that they must not be confused with Cassie Flowers (see p. 14). The Cassia Bark of Malabar may also come from this plant, though it is doubtless mainly procured from the wild plants of ***C. zeylanicum***. [*Cf.* Jonston, *Hist. Nat. de Arbor.*, 1662, 164.] Marco Polo gives interesting particulars of the Cinnamon and Cloves of Yunnan which in some respects recall the traffic in the Malabar products. [*Cf.* ed. Yule, ii., 32, 35, 38, etc.]

Ramtezpat.

Timber.

C. obtusifolium, *Nees*; the *ramtezpat, kinton, bara-singoli, nupsor, patihonda, dupatti, krowai, lulingyaw,* etc., is an evergreen tree of the outer Eastern Himalaya, Eastern Bengal, Khasia hills, Burma, Andaman Islands, etc. It gives a Timber said to be useful for boxes, planking, etc. The leaves are aromatic and used as a spice in place of those of ***C. Tamala*** and the bark is one of the trade qualities of Cassia Lignea, and after ***C. Tamala*** is perhaps the best known of all the qualities met with in India; it comes from Assam, Darjeeling and Nepal to Bengal and the United Provinces.

C. Wightii, *Meissn.*; is recorded as met with in the Nilgiri hills. Holmes (*l.c.* 55) mentions a sample of thick unscraped bark attributed to this species and sent from Ootacamund. It had a sharp taste recalling the flavour of nutmeg.

Cassia Lignea.

C. Tamala, *Nees ; Agri. Ledg.*, 1896, No. 38. The Cassia Lignea or Cassia Cinnamon; the *taj, kikra, kirkiria, sinkami, chota sinkoli, nupsor, dopatti, tamálá, thitchabo, thit-kya-bo, zarnab* (tree), *talíspatri, tálisha-pattiri, tajpat* or *tejpát, lavanga patte, dieng latyrpat* (leaves), etc. The word *tamáli* occurs in the *Raja Nirghanta*, and *tejpat* is apparently derived from the Sanskrit *tvach*. A moderate-sized evergreen tree of the Himalaya, rare from the Indus to the Sutlej, but common thence eastwards to East Bengal, the Khasia hills and Burma, between 3,000 and 7,000 feet.

Adams (Comment. in *Paulus Ægineta*, iii., 238) and other writers have identified the *Malabathrum* of the Greeks and of the Romans with the *tejpat* of India. There seems no doubt that the leaf of this plant has been traded in and exported from India for many centuries. The leaf is, in fact, a more important product than the bark.

History.

Two Chief Qualities.

History of Cassia Lignea.—Owing to the confusion which existed in former times with regard to the Cassia barks, it is almost impossible to give a connected résumé of the history of any one of them. It may be observed that even in the heyday of the East India Company the "Cassia" products mentioned in their records are almost invariably of Chinese origin. Hence Milburn (*Or. Comm.*, 1813, ii., 500), who gives a very clear account of the trade, both in the bark and the buds, warns traders against the coarse, dark and badly packed Cassia Lignea of Malabar. It is, however, interesting to notice that the most recent investigations show such a close connection between the Cassia trees of China and India that the former, which appears actually to extend into Burma and Assam, has been regarded by some authorities as a mere variety of the Indian ***C. Tamala***. As already observed, recent specimens of Cassia Lignea leave no room for doubt that the better qualities of the Assam bark are derived from the true ***C. Cassia***, *Bl.*, and are, therefore, the genuine Cassia Lignea of the ancients and the bark which is so largely exported at the present day from Canton. Concerning the Indian Cassia Lignea—the *taj*—there may be said to be two localities of supply, and thus two main sets of qualities: (*a*) Western and Southern India—the bark of ***C. zeylanicum*** mainly, and (*b*) Eastern and Northern India and Burma. obtained almost exclusively from ***C. Tamala*** and to a small extent from ***C. obtusifolium*** and ***C. iners***. Gamble suggests that the necessary forest regulations of Darjeeling may have interfered with or restricted the trade. [*Cf. Malabathrum*, Garcia de Orta, *Coll.*, xxiii.; also Comment. by Ball in *Roy. Ir. Acad.*, 3rd ser., i., 409; *Folium Indicum*

or *Tamalapatra*, Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 131; Jonston, *Hist. Nat. de Arbor.*, 1662, 172); Vincent, *Periplus, etc.*, 1800, app., 12-8; Wight, *Mad. Journ. Liter. Sc.*, 1839, xxii., reprinted in *Edinb. New Phil. Journ.*, 1840, xxviii., 20–32; Flückiger and Hanbury, *Pharmacog.*, 475; *Pharmacog. Ind.*, iii., 209.]

Gardens.

Khasia and Jaintia Hills.

Sylhet.

CULTIVATION.—In *The Agricultural Ledger* (*l.c.* 3) particulars will be found of the cultivation of *tejpat* in the Khasia and Jaintia hills. About six square miles are said to be under the tree. It is usually found in gardens or plantations of mixed jack and betel-nut palms. It grows readily where there is heavy periodical rain followed by brilliant sunshine, but excessive and continued moisture injures the flavour of the leaves. In the Khasia and Jaintia hills the trees are grown in regular plantations seven feet apart; the seedlings are raised in beds, and planted out permanently when the plants are five years of age. The tree takes five or six years to grow, comes into bearing at ten, and may continue to give annual crops for one hundred years. The cultivation is in the hands of the hill-men. In Sylhet the trees are self-sown; the ripe seeds fall from the trees into the soil and germinate. When the plants are about a foot high they are transplanted. Great care is bestowed upon them when they are young and tender. As constant exposure to the sun would kill the shoots, they are planted behind bushes or trees for protection. The undergrowth is kept down twice a year in the plantations for the first eight or nine years; after that the jungle is cleared once a year in April. In some plantations the soil is dressed, but in most it is never manured or irrigated.

The *tejpat* and cinnamon trees are different. The former are only used for their leaves, and no bark or only a small quantity is collected in the Khasia hills. No information is, in fact, available regarding special *Cassia Lignea* plantations, though a fairly large trade exists in the bark.

Crop.

Yield.

Collection and Crop.—"*Tejpat* is plucked in dry and mild weather, from October to December, and in some places the collecting is continued to the month of March. The leaves are taken once a year from young trees, and every other year from old and weak ones. On an average 15 seers may be obtained from one tree, but the quantity depends upon circumstances; a tree yields from 10 to 25 seers of leaves in a year. The average yield of leaf per acre in the Jaintia parganas is about 30 seers without, and 2 maunds with, twigs. The whole of the crop from 400 acres was worth last year as much as Rs. 1,100. The quantity of leaves from the Sylhet district last year calculated on the turnover of the traders was estimated at 14,470 maunds, and from the Jaintia district 20,000 maunds."

Plucking.

"In harvesting the *tejpat* the small branches are cut down with the leaves and dried in the sun for three or four days. The leafy branches are then tied up into convenient bundles ready for the market. In the other case, the leaves are separated from the branches and packed in bamboo nets of a cylindrical shape called *bora* or *jungra*, which are four feet long by two feet in diameter. The packages are carried down the *ghaut* roads of the hills by coolies to Sylhet." Mukerji (*Handbook Ind. Agri.*, 1901, 437-8) says that for propagation seed had best be obtained from Sylhet.

Food
(Condiment).

Regions of Supply.

Uses.—The leaves are commonly known as *tezpat* or *tejpat*, but since the Natives call the leaves of any species of *Cinnamomum* by that name there is some uncertainty as to which particular species is meant in certain localities. It appears probable that *C. Tamala* and its variety ***intermedium*** provide the *tezpat* of Bengal, the United Provinces and the Panjáb, whilst ***C. obtusifolium*** to some extent supplements the Bengal supply and ***C. albiflorum*** that of the Lahore bazárs. Gamble says that both bark and leaves of ***C. Tamala**, Nees*, and ***C. impressinervium**, Meissn.*, are collected and exported under the same names and without distinction from the Darjeeling forests. The leaves of all these species are used in food, and also employed with myrobalans in dyeing and in the manufacture of vinegar (see p. 1110).

Oil.
Soap.
Medicine.
Adulteration.

The outer layer of Cassia bark yields an OIL which is utilised in the manufacture of soap. Full details of the Chinese and other Cassia Oil may be obtained from Schimmel & Co's. *Reports* (April–May, 1903, 16; April–May, 1904, 18–23, etc.). No oil is distilled from these barks in India. Both bark (*taj*) and leaves (*tejpát*) are employed in MEDICINE, the latter being commonly identified with the "*Folia Malabathri*," or "Indian Leaf," which was held in great repute by the ancients. But when the bark is used instead of cinnamon great care is necessary to ensure its not being adulterated with the injurious barks of several species of ***Litsea***. [*Cf. Rept. Cent. Indig. Drugs Comm.*, i., 126.]

Cinnamon.

C. zeylanicum, *Breyn;* Talbot, *List Trees, etc.*, 1902, 283; De Candolle, *Orig. Cult. Pl.*, 146. The TRUE CINNAMON or *dárchíní* (Chinese-bark), *karruwa* (*karua*), *lavanga*, *ohez*, *sanalinga*, *eringolam*, *kurundu* (= in Ceylon "the wood"), etc.

Habitat.

A fairly large tree, native of Western and Southern India, Tenasserim and Ceylon; in the last-mentioned country it is extensively cultivated for its aromatic bark. There is no evidence of the economic cultivation in India of this tree, though it is occasionally planted as an ornamental and useful bush in Bombay, Madras and Bengal. As a wild tree, however, it is plentiful in Western and Southern India from the Konkan southwards, rising on the slopes of the Ghats to 6,000 feet in altitude.

History.
Two Forms.
Bhimsini.

History.—It is somewhat significant that while Garcia de Orta (1563) gives full particulars of both the Malabar and Ceylon industry and speaks of the plant in the former as plentiful and wild, subsequent writers should have ignored this fact and confused the whole subject. Rheede figures and describes two forms of ***Cinnamomum*** as met with in Malabar. These are doubtless the ***C. zeylanicum**, Breyn*, and ***C. macrocarpum**, Hook., f.*, discussed by Talbot. Is this the Camphor-wood called *Bhimsini* alluded to as a lofty tree of the Ghats by Abul Fazl in the *Ain-i-Akbari* (1590, 79) and by Kirkpatrick (*Letter of Tippoo*, 1786, 231)? Many cinnamon timbers are described as "Camphor-woods," and might easily have been thought to be obtained from the camphor tree. The name *lavanga* it will be seen is also given to the Clove (which see, p. 527) as well as to the Nutmeg (see p. 791), and perhaps points to the time when these plants were not separately recognised.

Indian Traffic.
Malabar Cinnamon.
Chinese Influence.

In India various barks, as also twigs with their adhering barks, are sold as CASSIA LIGNEA and CINNAMON. But we are hardly more able to distinguish these than were the 16th and 17th century writers. Cassia bark was historically the first to be known. The finest qualities were moreover said to come from China and the less valuable from Malabar. Cassia bark appears to have been known in China from about 2700 B.C. Malabar Cassia is mentioned by Strabo (A.D. 17) and in the *Periplus*, A.D. 63 (ed. McCrindle, 18). In most of the classic works of India and Arabia a bark is alluded to that can only have been Cassia Lignea or *Dár* (*dal*) *Chíní*. It is in Sanskrit known as *tvach* and *guda-tvach* (= sweet-bark). But it is in comparatively modern times only that Ceylon cinnamon appeared in the markets of the world. Garcia de Orta speaks of the Malabar as wild, thus leaving the inference permissible that Ceylon was cultivated (see below under Trade). He tells us that the Chinese traders exchanged their merchandise for the spicy barks of Ceylon and Malabar and carried these to Persian and Arabian ports. He suggests that the name *dárchíní*, given to these barks, took its origin from this circumstance. Garcia would thus seem to have been unaware that cassia bark was also well known in China and hence the Chinese may have only purchased

Arab Influence.

the Indian as a cheaper quality than their own. The Arabs, through whose hands much of the cinnamon passed, called it *kirfat-ed-dársini*, a word corrupted into *kirfah* and which survives as *kalfah*, the name given to-day for the commercial bark of Malabar. Garcia observes that the Chinese, in order to enhance the value of the bark sold by them, gave it mythical names and stories. Strabo speaks of cinnamon growing in South India—at the beginning of the torrid zone. The name cinnamon is thus considerably older than the time of the Chinese trade with India and was, in fact, intimately associated with the very earliest Arab dealings.

Ceylon.

The systematic cultivation in Ceylon does not appear to have been undertaken much before the Portuguese and Dutch conquests of the island (De Candolle). It became a State monopoly, and, as Garcia de Orta tells us, rose in price very greatly in consequence. The most stringent and cruel laws were instituted to protect the monopoly, which, on the island passing over to the British in 1796, were mitigated and finally in 1833 the cultivation was made free and thus ceased to be a State monopoly.

Oppressive Legislation.

[Numerous Indian writers might be mentioned on the subject of the production and manufacture of Cassia and Cinnamon, such as:—Acosta, *Tract. de las Drogas*, 1578, 2-18; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), ii., 76; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 358; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 262; Clusius, *Hist. Arom.*, in *Hist. Exot. Pl.*, 1605, i., 169; Piso, *Mant. Arom.*, in *Ind. Utri. re Nat. et Med.*, 1658, 165; Jonston, *Hist. Nat. de Arbor.*, 1662, 162–70, pl. 53 4; Herbert, *Travels*, 1677, 342; etc., etc.]

Cultivation.

CULTIVATION AND PREPARATION.—The following account of the propagation, cultivation, and method of preparing the bark is mainly an epitomised and annotated version of Nicholls' article (Textbook Trop. *Agri.*, 190-3), and is therefore not a statement of any South Indian industry, for in fact none is known to exist.

Although in its wild condition it grows to a large tree, the plant exists under cultivation as a coppiced bush. It is cut down to the ground at about the sixth year, when straight shoots spring up to be again cut down two years after, and in time the stools become of great size. The straight shoots are mentioned by all the early writers and are figured by Jonston (*l.c.* t. liii.).

Soils.

The best soil, says Nicholls, is a sandy loam mixed with humus, but the tree will grow in the tropics on almost any soil, though unsuitable soils and climates produce inferior bark.

Propagation.

Plants may be raised by cuttings, layerings, or by ripe and fresh seed. The usual way is to plant the seed out in the fields, at distances of 6 or 7 feet apart; the ground being well broken up, and wood-ashes mixed with the soil. Four or five berries are sown in each hole and branches of trees are laid on the ground to protect the seedlings from the sun. But if dry weather follows germination, which takes place in from two to three weeks, many of the seedlings may perish, and it will in consequence be advisable to have a reserve of plants raised in nursery-beds to fill up vacancies. After the plants are established, little more cultivation is needed than to keep the ground free of weeds.

Weeding.

Seasons.

By the sixth year the first shoots can be cut, when two or three will usually be 5 or 6 feet high, and in a condition for peeling. Two years afterwards the shoots that grow up after the first cutting may be reaped.

Preparation.—The shoots are cut off and the tops removed so that they are left from 3 to 5 feet long. The leaves and side branches are cleared and two longitudinal slits made with a sharp knife, one on each side of the shoots.

Separation of Bark.

When the cutting has taken place in rainy weather the bark comes away easily, but as a rule it is necessary to rub the sticks firmly with a piece of smooth wood, such as the handle of the knife; the rubbing helps to disengage the bark. The pieces of bark thus separated, after an hour or so, are put one within the other, collected

Scraping. Quills. Adulteration.

into bundles, pressed, and bound together. They are then left for a day or so, until a slight fermentation sets in, which allows of the scraping off of the epidermis and the pulpy matter underneath, by means of a curved knife. The barks are then put together as before, but cut into lengths of about 12 inches, placed on wickerwork platforms, and left to dry in the shade until the second day, then finished in the sun. As they dry they contract into the appearance of quills, hence that name was given to them. The dry spice is made up into bundles of about 30 lb. each, and three bundles are made into a small bale. The bark of the larger shoots cannot be made into quills, but is removed in thick pieces and sold with the bark of the prunings as "chips," which fetch a low price owing to inferior flavour. The estimated yield per acre is said to be 150 lb., but might probably be increased by high cultivation. The true cinnamon, it may be added, is very commonly adulterated, especially in powder form, with the Cassia Lignea discussed above.

Oils.

Oils.—Three Oils are obtained from *C. zeylanicum*: the bark yields essential oil of cinnamon, to the extent of ½ to 1 per cent.; from the leaves is expressed a brown viscid essential oil, sometimes exported from Ceylon as "Clove Oil" (it has a somewhat similar medicinal value to the true oil of cloves); and from the root a yellow oil which is specifically lighter than water and has a strongly camphoraceous flavour. In their report for April–May, 1904, Schimmel & Co. discuss several reactions for distinguishing between Ceylon cinnamon oil and cassia oil, with which the former is not infrequently adulterated. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 377–92.]

Indian Trade in Cassia Lignea.
Exports.

TRADE IN CASSIA AND CINNAMON. – ***Cassia Lignea.***—In Official Statistics returns are given of the imports from foreign countries and of the portions of these re-exported, but no mention is made of the exports of Indian-grown Cassia Lignea. On the other hand, under the name Cinnamon, returns are given of Indian-grown bark from Madras and Bengal, but no mention of Bombay. It would seem probable that these exports of Indian Cinnamon are, in reality, the exports of Indian Cassia Lignea. Regarding the Imports of the bark a slight increase is noticeable, viz. from 20,014 cwt., Rs. 5,41,135, in 1899–1900 to 24,075 cwt., Rs. 6,01,906, in 1902–3, and to 23,421 cwt., Rs. 6,92,559, in 1906–7. The most noticeable features in these imports are the extreme fluctuations in the trade from Hongkong (15,024 cwt. in 1899–1900 to 6,173 cwt. in 1903–4, and 10,955 cwt. in 1906–7), and the corresponding expansion in the traffic from Chinese treaty-ports. There was also a considerable increase (45 per cent.) in the imports from the Straits Settlements up to 1903–4, when the quantity imported was 5,795 cwt., but since then this has fallen to 467 cwt. in 1906–7. Three-fourths of these imports are taken by Bombay—the great Indian emporium in the drug trade. There is also a re-export which usually amounts in quantity and value to about one-fifth of the receipts. The chief countries to which the drug is re-exported are Persia and Turkey-in-Asia.

Imports. Re-exports.

Kalfah Bark.

The bark known as *kalfah* (to which reference has been made) is imported by Bombay town, coastwise from Malabar, and is apparently used to adulterate the Chinese bark. It sells at about Rs. 5 per maund of 37½ lb., or say 2½ annas a pound. According to the *Report of the Central Indigenous Drugs Committee* (1901, i., 119), the price of Chinese

Cassia is from 3 to 5 or even 8 annas per lb., according to purity. [*Cf.* also *Mus. Rept. Pharm. Soc. Gt. Brit.*, 1895–1902, 48–56.]

Uses.

Value.—The uses of cinnamon bark and oil, both in food and medicine, are sufficiently well known to render description unnecessary. In India and Ceylon cinnamon is largely replaced by *taj* or *kalfah* barks. The position of the Ceylon cinnamon with India may be judged of by the fact that the imports are unimportant, and moreover low-priced, so that it may be said there is hardly any demand in India for the fine qualities. But, conversely, the exports from India to Ceylon, of locally produced cassia bark or cinnamon, seem of expanding importance. This traffic was 5,393 lb., Rs. 2,530, in 1899–1900; 26,686 lb., Rs. 8,221, in 1903–4; and 21,040 lb., Rs. 7,697, in 1906–7. It goes mainly from Bengal and Madras and to a small extent from Burma. As already stated, there is no evidence whatever of any economic cultivation of *C. zeylanicum* in India, and the bark exported as cinnamon must therefore be Cassia Lignea, or at most wild cinnamon, the collection of which in N. Kanara is mentioned both by Talbot and Dymock as important. It may be here added that so long ago as 1687 Thevenot (*Trav. in Levant, Indostan, etc.*, pt. iii., 109) speaks of wild cinnamon in Cochin.

Imports Low-priced.

Wild Cinnamon Bark

D.E.P., ii., 329–31. Colocynth.

CITRULLUS COLOCYNTHIS, *Schrad.*; *Fl. Br. Ind.*, ii., 620; Duthie and Fuller, *Field and Garden Crops*, 1882, pt. ii., pl. 57; *Pharmacog. Ind.*, ii., 59; White and Humphrey, *Pharmacop.*, 1901, 145–6; Cooke, *Fl. Pres. Bomb.*, i., 537; Duthie, *Fl. Upper Gang. Plain*, i., 374–5; CUCURBITACEÆ. The Colocynth, *indráyan, mákal* or *mukhál, khártuma, tuh* or *karwa-tu, ghúrúmba, trúná deda, henzil, kiyási*, etc. A creeping or climbing herb found wild in the waste tracts of North-West (Sind, Dera Ismail Khan, Multan and Bhawalpur, etc.), Central and South India; is indigenous also in Arabia, Western Asia, Tropical Africa and the Mediterranean region.

Habitat.

Wild Fruit.

The fruit (the "wild gourd" of 2 Kings, iv., 39) is in size and shape much like an orange, marble-green on the surface and changing to yellow as it ripens. The fresh fruit is sold by the herbalists of India, being collected from wild supplies. To meet the requirements of the Medical Depôts an effort has been made to cultivate it specially at the Saharanpur Botanic Gardens. The intensely bitter taste of the pulp is due to an amorphous yellow glucoside, *Colocynthin*, which is found in it to the extent of about 0·6 per cent., but not in the seeds. The fruit is a drastic purgative, and is so used both in Native and European MEDICINE. The Indian extract is in fact quite as active as that of the European drug. The yield is about 110 lb. compound extract to 60 lb. dried fruit.

Trade.

The seeds contain from 15 to 17 per cent. of a fixed OIL which is said to make a useful illuminant, but though inquiries were recently instituted in Sind and other localities, no one could be discovered who was in the habit of using the seeds in any form. For the London market the peeled fruit is imported chiefly from Smyrna, Trieste, France, Spain, and more rarely from Persia. The unpeeled fruit is brought from Mogador. The Indian fruit has a much thinner pulp, which cannot be separated from the rind. According to the authors of the *Pharmacographia Indica*, large parcels, collected and dried up country, come into market in December to January and are sold at about Rs. 1 per 100 fruits. [*Cf. Rept. Cent. Indig. Drugs Comm.*, 1901, 154; Dowzard, *Pharm. Journ.*, Sept. 12, 1903.]

D.E.P., ii., 331–3. Water-melon.

C. vulgaris, *Schrad.*; *Fl. Br. Ind.*, ii., 621; Duthie and Fuller, *l.c.* pt. ii., 56, tt. 55–6; Duthie, *Fl. Upper Gang. Plain*, i., 375; Cooke, *Fl. Pres. Bomb.*, i., 537; the Water-melon or *tarbuza, tarmus, kalinda,* *hindwana*, *kalingad*, *kalangari*, *karigo*, *pitchapullum*, etc.; *pateca*, Portuguese, and *batiec indi* (*battikh*) Persian. It appears to be the Anguria of many ancient herbalists and travellers, and the *bathiec*, *batiec*, *bittch*, etc., of the Arabs. It is the *abattichim* (melons) sighed for by the Israelites after the exodus.

An extensive climbing annual, cultivated throughout India and all warm countries. Is supposed to be indigenous in tropical Africa. It is usually sown in January–February, the fruit ripening in the beginning of the hot season. In the United Provinces a special form, known as *kalinda*, is sown in June and ripens in October. In Western India (Sind more especially) the water-melon is a *kharîf* crop mainly. Very frequently grown on the sandy beds of rivers, where plenty of room and a copious supply of water are available. Mention is often made, by writers on this subject, of a special form grown in Bikanir on almost pure sand, the fruits being often practically underneath the sand. There are thus doubtless many cultivated conditions or states, that vary in the colour and flavour of the pulp, and season and locality of production. The wild plant may be either bitter or sweet without any observable structural differences. The bitter form (***C. amarus***, *Schrad.*) comes very close to ***C. Colocynthis***, when that species is cultivated. The bitter water-melon is in Sind known as *kirbut* and is used as a purgative MEDICINE.

Habitat.

Seasons.

Special Races.

Bitter and Sweet.

Medicine.

The water-melons of the Upper and Central Provinces are the best. They are extensively employed in the preparation of sherbets. The seeds yield a limpid OIL used both as an illuminant and in cooking. In times of scarcity they are pulverised and baked into bread. In medicine, they are in considerable demand on account of their cooling, diuretic and strengthening qualities. [*Cf Ain-i-Akbari* (Blochmann, transl.), i., 65; Garcia de Orta, *Pateca*, *Coll.*, xxxvi.; also Comment. by Ball in *Roy. Ir. Acad.*, 3rd. ser., i., 653; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 35; Mandelslo, *Travels*, 1638, in Olearius, *Hist. Muscovy, etc.*, 1662, 86; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 196; Lawrence, *Valley of Kashmir*, 348; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 230, etc. For the *Anguria* or *Batiec* or *Pateca* :—Rauwolf, *Trav.*, ii., 4, in Ray, *Collection Travels*, 1738, 124; Coryat, *Crudities*, 1611, i., 396; Salmasius, *Hom. Hyles Iatricæ*, in *Plin. Exer.*, 1689, 37; Rumphius, *Batteca* or *Battich*, *Herb. Amb.*, 1750, v., 400–3, t. cxlvi.; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 252; etc.]

Oil.

Var. fistulosus, *Stocks*; Duthie and Fuller, *l.c.* pt. ii., pl. 47; the *tandus*, *tendu*, *tensi*, *tinda*, *meho*, *alvinda*, *titak*, etc.

This seems a peculiar form fairly local and much less known than the proceeding. Chiefly met with in the United Provinces, Panjáb and Sind, where it is specially designated *dilpasand*. Cultivated along with other melons from April to October, and eaten as a VEGETABLE, not as a fruit, being cut into sections, the seeds removed, then boiled in water, next in milk. Cut into still smaller pieces it is cooked in curry, and also fairly largely pickled and candied. It is in much demand both by Muhammadans and Hindus, but appears as a rule unknown to Europeans. The seeds are used MEDICINALLY. They are also dried and eaten parched.

Vegetable.

Medicine.

CITRUS, *Linn.*; Bonavia, *Cult. Oranges and Lemons Ind., etc.*, 1890; also *Fl. Assyr. Monuments*, 1894, 65–72; Victor Loret, *Le Cédratier*, 1891; Garcelon, *Fifteen Years with the Lemon*, 1891; Moore, *Orange Culture*, 1892; Nicholls, *Textbook Trop. Agri.*, 1892, 144–58; Cooke, *Fl. Pres. Bomb.*, 1901, i., 188–91; Duthie, *Fl. Upper Gang. Plain*, 1903, 139–42; Prain, *Beng. Plants*, i., 306–7; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 276–84; Brandis, *Ind. Trees.*, 122–3; RUTACEÆ.

D.E.P., ii., 333–58.

Literature of the Orange, etc.

The different forms of the Orange, the Lemon, the Citron, the Lime

Production in the Tropics.

and the Pomelo constitute a tropical assemblage of fruits in many respects comparable with the apple, the pear, the peach, the plum and the cherry - a temperate series—though the former are infinitely more valuable than the latter, because more widely cultivated and more extensively used. Moreover, since the orange is consumed very largely in temperate climes, cultivation in the tropics has to be made on the basis of the foreign as well as the local demands, so that oranges, lemons, etc., have become regular articles of trade all over the world. Until very recently Europe obtained its supplies of these from the warm temperate tracts of South Europe itself and from the islands of the Mediterranean and the Atlantic, adjacent to Africa. For some years the quicker transit of steam navigation has permitted supplies to be drawn from a greater distance than formerly, and both Europe and America have, in consequence, come to be very largely supplied by the West Indies. The great success recently of the fruit trade of these islands has given a useful suggestion of India's possibilities. There would seem every chance that a large trade may in the future be done in exporting some of the fruits of India to Europe, more especially the thin-skinned Bombay pomelo. [*Cf.* Ferrari, *Hesper.*, 1646; Jonston, *Dendr. Hist. Nat. de Arbor.*, 1662, 10–27, pl. vi–xviii.; Commelyn, *Hesper.*, 1683, 1–47; Salmasius, *Plin. Exer.*, 1689, 666–77; Lecomte, *Beschr. Keyser. China*, 1698, 79; Sterbeeck, *Citricult.*, 1712, 1–60, 66–181; Volkamer, *Nurnb. Hesper.*, 1708–14 (2 vols.); Clarici, *Ist. delle Piante*, 1726, pt. iv., 593–751; Rumphius, *Herb. Amb.*, 1750, ii., tt. 24–35; Forster, *Pl. Esc.*, 1786, 35; Gallesio, *Traité du Citrus*, 1811; Macfadyen, *Citrus of Jamaica*, in Hooker, *Bot. Misc.*, 1830, i., 295; Targioni-Tozzetti, *Cenni Storici, etc.*, 1853; also Review of same by Bentham, *Journ. Hort. Soc.*, 1855, ix., 133–81; Risso et Poiteau, *Hist. et Cult. des Orangers*, 1872; De Candolle, *Orig. Cult. Plants* (Engl. transl.), 1884, 176–88; Lelong, *Cult. Citrus in California*, 1900.]

West Indies.

India.

Literature of the Orange, etc.

History.—So much has been said on the history of the species of ***Citrus*** in the works above indicated, that it seems almost superfluous to attempt a review of the more interesting particulars, except such as have a practical bearing on India. The Sanskrit and Chinese records of the properties and uses of these plants carry our knowledge back to a time prior to the first mention of the European tradition of the Garden of Hesperides, with its golden-coloured and beautiful fruits, whatever these may have been. [*Cf.* Susruta, *Ayurvéda*, (d'Hanvantare) ed. Hessler, 1844, iii., 179.]

It seems fairly certain that the citron fruit had been carried to Europe by traders long before the attempt was made to cultivate the plant there. It was valued as a perfume and also used to protect clothes from insects. Pieces of certain imported coniferous woods were similarly so employed, and the Romans appear to have supposed that the fruits brought from Media were those of the self-same plant as the scented *cedron* wood. There can be little doubt, therefore, that the modern word Citrus was derived from Cedron and owes its origin to the circumstance mentioned.

European Classic Authors.

Cultivation in Europe.

Theophrastus (about 350 B.C.) calls it the *Malum Midicum* or *Molum Assyrianum*, and thus may be viewed as confirming the early traditional source of the Citron. But he speaks of it as raised from seed sown in vases and seems to be alluding to that instance from hearsay, as the practice with the Medes, rather than to be narrating a custom followed by the Greeks. There is, however, an amusing story contained in a fragment of the comedy of the Antiphanes, quoted by Athenæus, which, if it can be trusted, would suggest a possible much earlier cultivation in Europe than can be established by direct historic facts. So again the compilation known as the *Geoponica* (prepared in the 10th century) is supposed to be quoting certain authors who describe the cultivation of the citron several centuries before Christ, but here again it is perhaps hardly desirable to put much confidence in these writers. It may thus be affirmed that direct evidence of cultivation in the gardens of the Romans does not exist prior to the first century of our era.

Palladius (*De re Rustica*, iv., 10), who lived possibly about the fifth century (A.D.), narrates the methods pursued by him in cultivating the plant in his Sardinian and Neapolitan possessions, so that its cultivation in Italy by the 3rd or 4th centuries may be accepted as having been fully established, though for many centuries the progress made in Europe was but slow, down to the 11th or 12th centuries.

Derivation of Name Citron.

It may be said that while the orange is indigenous to China, and the limes to India, that the citron originated very possibly in Persia and Media, while the lemon is so closely associated with the Arabs as to suggest its having come from Arabia. The Arabs, at all events, carried its cultivation to Africa, Egypt and Europe. In the 10th century, for example, we read of them conveying it from the gardens of Oman to Palestine and Egypt. So also it is generally accepted that the fruit held in the hand by the Jews during the Feast of Tabernacles has for many centuries past been the citron. Risso has, however, produced evidence which he thinks goes to show that the Hebrews did not very possibly know the citron much before the beginning of the Christian era, hence he contends that it was very likely not the fruit so used by the early Jews. Other writers have, however, contended that the Jews were scarcely likely to have changed the symbol and yet retained the ceremonial. And it is, moreover, well known that a close relationship subsisted for many centuries between the Hebrews and the people of Media and Persia, so that there is no reason why they should not have known of the citron long before the Romans. There is, however, a long interval between the first European classic references to the plant and the detailed accounts of medicinal and horticultural writers. To bridge over this gap, Loret assumes a knowledge in these plants, possessed by the Arabs, Jews and Egyptians, very much more ancient than the earliest historic record. For example, the earliest Arab and Persian writers who knew of the citron and lemon are:—Serapion (*De Simpl.*, i., 1) and Rhases (*Cont.*, i., *ult.* i., 219), who describe the former, while the latter is alluded to by Ibn Baithar. Avicenna (*De Med.*, ii., 2, 116, 433)—the author most frequently cited—apparently confused these plants. [*Cf. Paulus Ægineta* (Adams Comment.), 1847, iii., 472.]

Arab Writers.

The orange was not known until much later than the citron or lemon. Targioni-Tozzetti tells us that it was conveyed from India to Arabia about the 9th century. We have no knowledge of its having reached Europe for a couple of centuries later, when it seems to have been carried by the Moors to Seville. In the 13th century we read of its cultivation at Palermo and Rome. But, according to the most generally accepted opinion, the bitter orange reached Europe before the sweet. Lecomte says that the Portuguese claim to have taken the sweet orange from China to Portugal somewhere about 1545.

Indian Authors.

It is remarkable that many of the Indian authors, who might be expected to afford useful historic particulars regarding the citron, lemon and orange, are silent regarding these plants. Marco Polo makes no reference to them, but Varthéma (*Travels* (ed. Hakl. Soc.), 1863, 190), who in 1510 visited Cananor and subsequently Ceylon, speaks of the sweet oranges (*melangoli*) of both places, and says of Ceylon that they were the finest in the world. Vertomannus (*Voy.*, in *Hakl. Voy.*, 1811. iv., 577), a gentleman of the city of Rome, who also visited Cananor and Narsinga in 1503, says the "soyle beareth neyther wheate nor vynes, or fewe other fruites, except Oranges and Gourdes." Baber (*Memoires*, 1519 A.D., 327–9) mentions nine different kinds of ***Citrus***, as known to him. This is the earliest complete statement regarding Indian cultivation. The *Ain-i-Akbari*, written 1590, amplifies some of the particulars given by Baber, but adds nothing very material. [*Cf.* Blochmann, transl., i., 69; also Jarrett, transl., ii., 124.] The Emperor Akbar, we are told, encouraged the cultivation of all fruits and brought expert gardeners for that purpose from Persia and Tartary, who doubtless carried to India with them all that was good and desirable in the way of new fruits from their own countries.

Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), 1598) makes frequent mention of the oranges, lemons, etc., of India, Ceylon and other countries visited, but in such language as to imply that his readers knew everything about them. Rheede, on the other hand, who, in 1686, figured and described the plants of Malabar, and thus practically of Cananor, makes no allusion to the orange or the lime, while Herbert (*Travels*, 1677, 333) speaks in the highest terms of the oranges and lemons of Mangalore: in the case of the oranges, "the rind," he tells us, "was no less pleasant than the juice." A century or so later Rheede and Herbert were followed by Rumphius, who gives a full description of several

Wild

China. **Cintra.**

oranges, lemons and pomelos. One or two of these he speaks of as wild. The sweet orange, however, he regarded as a native of China, but adds, " some consider it a native of Amboina." Numerous writers refer to the efforts made in India to improve and increase the orange and lemon supplies of that country. There need, therefore, be little cause for surprise that the oranges of Cintra should have reached India even before Baber's time. Dr. Hunter long years ago suggested that the name for one of our best-known forms of orange, viz. *sengtereh* (of Baber) or *santara* (as it is nowadays called), was but a Hindustani corruption of Cintra, thus indicating its having been brought from Portugal. The name ***aurantium*** given by botanists to the orange does not come from *auram* gold, but is derived from the Arabic *nárandj*. This became *nárendj* (*narang*) in the Persian, and its equivalent in Sanskrit is *nágaranga* and in the Hindustani *nárangi*. Names that begin with *nar* generally denote fragrance. The name orange came to English through the Moors, and became *náranjo* in Spanish, *laranga* in Portuguese, *arancio* in Italian, *oranger* in French, *orangenbaum* in German, and the like. [*Cf.* Ligon, *Hist. Barbados*, 1657, 69; Terry, *Travels E. Ind.*, 1665 (ed. Havers), 343; Ovington, *Voy. Suratt*, 1689, 423; Le Comte, *Mem. de la Chine*, 1696, i., 173; also Bretschneider review, *Hist. Europ. Bot. Disc. in China*, 15; Forster, *Pl. Esc.*, 1786, 35; *E.I.C. First Letter Book*, 81; Wise, *Hindoo Medicine*, 191; Wiesner, *Die Rohst. des Pflanzenr.*, i.; 653, ii.; 584, 631; Joret, *Les Pl. dans L'Antiq.*, 1904, 282–3.]

D.E.P., ii., 335–48. Orange.

C. aurantium, *Linn.; Fl. Br. Ind.*, i., 515; Roxburgh, *Fl. Ind.*, iii., 392; Woodrow, *Note on the Oranges and Lemons of India*, 1890; Deman, *Relative Merit of Stocks on which to Bud Oranges, U.S. Dept. Agri. Bull.*, 1891, No. 4; also *Division of Pomology, Bull.* No. 1, 57–87; *Rept. Settl. Amherst*, 1891–2, 47–50, 160–1; 1896, 24–5; *Kew Bull.*, 1894, 117–9; 1895, 266–71; Webber, *Fert. of Soil as affecting the Orange in Health and Disease*, in *U.S. Yearbook Agri. Dept.*, 1894, 193–202; Stephen, *Supt. Gov. Gardens, Nagpur*, 1899; Mukerji, *Handbook Ind. Agri.*, 1901, 490–2; Aaronsohn und Soskin, *Die Orang. von Jaffa*, in *Der Tropenpflanzer.*, 1902, vi., 341–62; Cooke, *Fl. Pres. Bomb.*, 1903, i., 190–1; Duthie, *Fl. Upper Gang. Plain*, 1903, 141–2; The Bitter (or Seville) and also the Sweet Orange.

Bitter. **Sweet.**

The bitter (or Seville) orange, though sometimes spoken of as indigenous to India, is there very little cultivated. The so-called wild, or perhaps only fully acclimatised plants that have been recorded as met with, are botanically nearer the sweet than the bitter (or marmalade) orange. It seems highly probable, on the other hand, that at least some of the forms of the Sweet Orange came to India *viâ* Assam, the route along which many other Chinese plants have passed westward into Hindustan. There may be said to be four or five chief centres of Indian orange production:—Sylhet in Assam; Nagpur in the Central Provinces; the lower ranges of the Eastern and Central Himalaya (Sikkim, Nepal, Garhwal and Kumaon); Delhi in the Panjáb; and the Deccan and South India (Poona, Coorg, etc.).

Chief Kinds.

Bonavia speaks of four chief races of this fruit, viz. (1) the *Santara* (a word which he writes " Süntara " and regards as of Sanskrit origin and not (as stated above) a corruption from *Cintra*); (2) *Keonla*, or the common *naringi*, produced here and there all over the country in gardens, not special plantations; (3) the *Malta* or *Portugal*—the blood-orange, introduced in 1852 and now fairly successfully produced at Gujranwala and also in gardens at Lucknow; and (4) the *Mandarin* of some writers (***C. nobilis, var. major***), a native of China and Cochin-China and the *Tanjerine* (***C. nobilis, var. minor***). Both these are occasionally met with in gardens but can hardly be regarded as important Indian fruits, although one of them appears to have been crossed with the *santara* in producing an orange commonly met with in some parts of the Deccan and South India, which is sometimes called " Indian Mandarin."

Santara.

The *santara* or *sungtura* (*nágaranga* of Sanskrit) is by far the best quality, and may be said to be distinguished by its yellow colour and loose skin or jacket. This is the orange of the special Indian plantations where orange-growing becomes an important industry. But there would appear in India to be several very distinct forms of the *santara*, due very possibly to peculiar methods of cultivation or special climates. The distribution of the races of *santara* orange might be given as follows:—*in the north*, Nagpur, Delhi, Alwar, Gargaon, Lahore and Multan; *in the west and south*, Poona, Shevaroy, Madras, Coorg and Ceylon; *in the east*, Nepal, Bhutan, Assam, Khasia and Burma.

Races.

Sylhet and Khasia.

China Orange.

The ***Sylhet*** or more correctly the ***Khasia*** orange is the best of the series, and it may be described as the fruit known in Europe as the China orange. One of the most useful papers on this subject is that by C. Brownlow (*Journ. Agri.-Hort. Soc. Ind.*, 1869, 372, briefly reviewed in the *Dictionary*). The Sylhet orange, he says, is invariably raised from seed, and the plants come into bearing in four to six years. It is believed that the seedlings do better than grafts or buddings, though the latter come sooner to maturity and afford a more uniform quality. When grafting is pursued the stock usually employed is the lime, and some say the wild plant is preferable to the cultivated.

Khasia Hills.

Since the present article was penned, B. C. Basu has contributed (*Agri. Journ. Ind.*, 1906, i., pt. i., 62–7) a most interesting account of the Khasia hills orange and its cultivation, for which space can only be found for the merest abstract. The area where produced, he observes, is comprised within one hundred square miles. The plantations commence on the plains and rise to an elevation of 1,500 feet. The gardens extend thus for some distance into the interior along the deep valleys which cut up the southern face of the Khasia hills. From that narrow tract of country is drawn the bulk of the oranges consumed in Bengal and Assam. The great earthquake of June 1897 destroyed, however, a large number of the orange gardens, many of the most productive of which lay on the banks of the hill streams and owed their fertility to the silt left by the annual floods. The orange is said to do best on limestone soil. The Khasia people recognise only one variety, though they admit a wide range in quality exists—dependent mainly on soil and the aspect of the garden. The special merits of individual plants are not perpetuated owing to the almost invariable habit of raising stock from seed. The fruits with thick rind are preferred even though the pulp is less juicy, because they stand handling better. So also late ripening is advantageous in point of price.

The Earthquake.

Limestone.

Raised by Seed.

Basu's account, it may be observed, differs here and there very slightly from that given by Brownlow. Seedlings, he says, are transplanted when two or three years old, and during May and June. A hole is made and the young plants deposited at distances approximately of 10 feet apart. Manure is never used. By the end of the rains a number of shoots have usually formed, and in time one of these is preserved, and the rest, as also the parent stem, removed. The plants begin to bear in eight to ten years and the duration is uncertain owing to the ravages of the borer insect, which destroys large numbers of plants annually. The orange season commences in November and closes in March. The export is in the hands of Bengali traders, who mostly live in Sylhet, hence the orange being often spoken of under that name. The usual wholesale price is from Rs. 10 to 20 per " hundred," equivalent to about 2,300 fruits. The supply intended for Bengal is taken down to Chhatak. If carefully

Transplanting.

Come into Bearing.

Price.

arranged on a trellis, no two fruits being allowed to touch each other, and then suspended from the roof of the house, the fruit may be preserved for months.

Supply in Cold Season.

Possible Hot-season Supply.

This orange is conveyed by boat to Calcutta, where it is sometimes spoken of as *kamlá-nebu*, from which circumstance Prain thinks it may be inferred the orange was derived from the kingdom of Comilla to the east of Calcutta, and not from Upper India. There is but one complaint in Bengal against the present supply, namely that it comes in the cold in place of in the hot season. This has led to numerous efforts, with indifferent results, to obtain a second supply of equal merit from other localities. In Kullu, for example, the fruiting season is much later, and an effort has accordingly been put forth to send supplies to Simla in April and May.

Nagpur.

Careful Cultivation.

Budding on to Limes.

Full Bearing.

Two Crops.

Seasons.

Later than Sylhet.

Nagpur.—Mr. J. H. Stephen, Superintendent of the Government Botanic Gardens, Nagpur, published in 1899 an instructive account of the production of oranges in the Central Provinces. Mr. A. Ross, in a letter published in Firminger (*l.c.* 277), furnishes other particulars of interest. Stephen inspected several large orange plantations and found that where carefully cultivated and liberally irrigated the trees were healthy and fruited freely; where neglected, the yield was so low that the gardens were not remunerative. In every instance the plant grown was the Nagpur *suntra* budded on the sweet lime. This is believed to produce a thinner skin and a sweeter and more luscious fruit than when budded on the citron or *jambiri*. The Sylhet system of raising from seed seemed nowhere to be followed, because it is believed that such plants take from fifteen to twenty years to come into bearing. The lime is sown in January to March, and when a year old the budding of the orange is made on the seedlings. They mature in the sixth or seventh year, and in about nine to twelve years are in full bearing; after that date they decline. In Nagpur the orange yields (or can yield) two crops a year. The plants flower in February to March, and the fruit is ripe in November to December or January. The second flowering is in June to July, and the fruit ripens in March to April. The oranges of the second crop are the sweetest, and, coming as they do at the beginning of the hot season, are much valued. These are plucked green, and thus are rarely allowed to change into the characteristic yellow colour of the other crop. On this account some writers have regarded them as being bergamot oranges.

Manure.

High Cultivation.

Influence of Budding.

About the middle of May the roots are exposed and the plants manured (according to Ross, the roots are exposed and the manure given in October). Pruning is unknown in the Nagpur groves, and, except to be watered freely in the hot season, the plants receive little or no further attention. R. S. Joshi, Rai Bahadur, has just published an account of the orange cultivation of these provinces (*Agri. Journ. Ind.*, 1907, ii., pt. i., 64–9) which will be found to richly repay perusal. In the details of cultivation he makes, to all intents and purposes, the same facts as already exhibited. He urges the necessity for high cultivation, especially on soils with a liberal supply of lime, and reaffirms belief in budding. "The stock generally used," he says, "is the sweet lime (*mitha nimbu*), but the common citron (*zamburi*) is also very often utilised. Buds of the orange grafted on the latter stock produce trees which yield fruits with a very loose skin, whilst those on the former stock have a more closely adhering jacket, showing that the stock has a distinct influence on the bud. The loose-jacket oranges are preferred for local consumption but are not so good for export, as they do not stand carriage well. Trees raised from citron stock come into bearing more quickly and have a somewhat longer life, but the fruit from the sweet lime is sweeter and has a thinner skin."

Diseases.

Speaking of the diseases of the orange, Joshi says that in Nagpur the most serious is caused by a fungus which results first in the withering of the tips of the branches, the rot gradually extending down till the whole tree is destroyed. The produce of the Nagpur gardens goes mainly to Bombay, but recently Calcutta has drawn on the Central Provinces. If the late crop could be made a special feature, it seems probable the Nagpur supply would be much appreciated by Bengal.

Exports to Bombay.

Delhi

Delhi.—The oranges of this locality are inferior to those of Sylhet and Nagpur. The rind is thick and the juice relatively poor, both in flavour and quantity. The supply of the so-called Delhi orange, which, in addition to meeting the local markets of the United Provinces and the Panjáb is to some extent drawn upon by Bombay, comes from the neighbourhood of Delhi itself and from Gargaon, Saharanpur and Alwar, etc. Nepal, Garhwal and Kumaon produce small but sweetly flavoured *santara* oranges. Dr. Bonavia tells us that the sweetest orange he ever tasted was grown in Nepal.

Santara Oranges.

Poona.

Poona.—Woodrow wrote a useful report of the orange cultivation of Western India which was published by the Director of Land Records in 1890, and subsequently epitomised and amplified by Cooke. In addition to the *santara* orange, the *ládu* of the Deccan is largely produced. This has often a malformation in the form of a supplementary series of pips near the apex. The Mozambique orange and also the Mandarin, or what is so called (*lál ládu*), are frequently met with. Indian Mandarins are good to look at but inferior in flavour, and, as already observed, the *lál ládu* is probably only a hybrid Mandarin.

Hybrid Mandarin.

Coorg, Mysore and Nilgiri.

The ***Coorg, Mysore and Nilgiri*** oranges are much spoken of, and constitute the chief supply of the city of Madras. The Coorg is the form most in demand. It seems a cross between the ordinary *santara* and the Maltese. Mr. Gustav Haller (*Agri. Journ. Ind.*, 1906, i., pt. ii., 127–9) has very recently written a useful account of the "Orange Cultivation in Coorg." The method of cultivation he speaks of as very simple. Seeds are sown in nurseries, where the plants remain till they are one or two feet high, and are then transplanted 18 to 20 feet apart. The only subsequent attention given is to protect the plants from damage by cattle and to keep the fields clean. At six to seven years the first crop is picked; and if success is to be attained the plants must now be manured, but very little is usually done in this respect. The flowering seasons are October to December, and again April to June. The fruits of the former are of little consequence, as they do not ripen properly and constitute the so-called monsoon crop, for which there is little demand. The other crop is of great value, is harvested from January to March, and is known as the hot-season crop. The average duration of the plants would appear to be about thirty years. Lastly, Haller discusses the diseases and pests of the orange, and mentions a *Loranthus* parasite and the borer beetle as being the most prevalent.

Raised from Seed.

Bearing.

Seasons.

Diseases.

Trade.

Trade in Oranges.—It is quite impossible to furnish any particulars

Surplus Stock.

Experimental Parcel.

as to the extent of the traffic in these fruits. They do not appear separately in either of the records of internal traffic or external trade. In the *Assam Administration Report* for 1901–2 it is stated the exports from that province came to 74,000 maunds, valued at Rs. 2,80,000. But we have no information as to the area and yield for the whole of India, and therefore the total production cannot be even conjectured. The suggestion has been made above that India might with advantage follow the lead given by the West Indies, and look to Europe and even America as hopeful markets for the profitable disposal of surplus fruits. Before this can be seriously contemplated production must be put on a more certain basis than at present, and this is not likely to be accomplished until European planters of India are induced to become orange growers. Some few years ago (1894–5) a few parcels of Nagpur oranges were sent to London. Messrs. W. Hutchinson & Co. reported on these. The brokers pronounced the fruit the best they had ever seen, and valued the oranges at 3*d.* apiece. They arrived when the supply of oranges from other countries had come to an end, and were thus much appreciated. The supply was, however, discontinued, and never seems to have been again renewed. To organise and maintain a foreign market an unfailing supply of a fixed quality must be assured. This would mean increased production with the definite idea of export. The demands of the local markets seem to absorb the present supplies, and the profits of production are sufficiently high, it might be conjectured, to have tempted increased cultivation.

D.E.P., ii., 349. Pomelo.

C. decumana, *Linn.; Fl. Br. Ind.*, i., 516; Tussac, *Fl. Antl.*, 1824, iii., 73–4, pl. 17, 18; Bentham, *Rev. of Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 172. The Shaddock, Pomelo, Pumelnose (*pampelmousse*, Fr.); the *maha-nibu*, *batávi-nebu*, *sadaphal*, *chakotra* or *chukotura*, *bator-nebu*, *bijoro*, *papanas*, *bombalinas*, *púmplemús*, etc. It has no Sanskrit name. It was known to the early Dutch traders as Pompelmoes (= pumpkin-citron), hence some of the modern names. It reached India and Ceylon in the 17th century.

Habitat.

Introduction into India.

Rapid Distribution.

The pomelo is presumed to be a native of the Malay Archipelago. Introduced into India and Ceylon from Java, hence the name *batávi-nebu*; carried to the West Indies by a Capt. Shaddock. Rumphius, followed by Roxburgh, was the first botanical author who described this fruit, although the suggestion may be offered that the *Pomum Adami Commune* (or Black Lemon) of Ferrari and also of Commelin bears a strong resemblance to the pomelo. It is certain that neither Baber (1519) nor Akbar (1590) allude to it. Buchanan-Hamilton studied (1807–11) the districts of "Dinajpur, Rangpur, Paraniya, Bhagelpur, and Bihar, and the cities of Patna, Shahabad and Gorakhpur. Upon each of these he submitted to the Government a voluminous report," but only one, viz. Dinajpur, was ever published, as written by the author, and that not until 1833. He there says that this plant was known as *batabi*, but that it could scarcely yet be said to have made its way from the gardens of the Europeans (*Stat. Acc. Dinaj.*, 196). In 1897 I personally explored a considerable portion of the districts of Dinajpur, Rangpur and Bogra, and may safely affirm that no village exists now without its pomelo trees. In India and Burma at the present day, it is, in fact, one of the most common of fruits, but more especially so in Bengal and South India than in the United Provinces, the Central Provinces or the Panjáb. The best quality

Bombay Pomelo.

is the thin-skinned Bombay pomelo, hence the South Indian name of *bombalinas*.

Season.

It is a favourite with the Natives of India, the pulp being either white or red, according to the variety grown. The best fruit is to be had about Christmas time, but certain qualities may be got very nearly throughout the year. In Bengal the season is August to December. The name "Pomelo or Pompoleous" (in Cape Colony, Pomelnose) is usually given to the large-sized fruit, "Shaddock" to intermediate sizes, and "Forbidden Fruit" to small forms. The cells of the pulp are very large and naturally separate from each other—a peculiarity that has led some people to speak of it as the "Grape Fruit" or "Grape Orange." The separated pulp is largely eaten in India as salad. The Bombay pomelo is the one that should be most cultivated and exported. It may be raised from seed sown in February, or by budding in February to March on the common lime, or by layers made in pots supported high among the branches. Seedlings take longer time to come into bearing than layerings or buddings, and are less certain.

Propagation.

Exports.

The exports from the Bahamas, Cuba, Jamaica and Florida to the United States have recently assumed considerable importance. The traffic from the Bahamas alone was in 1902, 728,000 fruits. This shows what might be done were India to commence to export Bombay pomelos to the United Kingdom.

D.E.P., ii., 349-58.

C. medica, *Linn.; Fl. Br. Ind.*, i., 514. There are many very distinct forms of this species met with under cultivation in India. Of these, the following abstract of the voluminous information available may help the reader to discover the special details desired :—

Citron.

1. **Var. medica proper.**—The Citron, Adam's Apple, etc. Bears many names in the vernaculars of India, such as *bijaura* or *bajauri* and *bijori* (suggestive of the province of that name in Kafaristan which Baber tells us was famous for its citrons even in 1519), *limbú, nimbu* (or *bara nimbú*) *turanj* (its Persian name), *honsa nebu, beg-pura, balank, mavalung*, etc. Its Sanskrit names are *mátulunga, phalapura* and *vijapura.* Is said to have been found wild in Chittagong (an opinion not alluded to in Prain's *Bengal Plants*); by others it has been reported as wild in the Khasia and Garo hills and also in Kumaon.

Cultivation.

Fingered Citron.

Moulded Citrons.

The Citron is cultivated sparingly in the warm moist regions of India, one form being so large as to resemble a pomelo (is possibly the Poncire citron of Europe.) Another is the fingered citron, a curious fruit that Bonavia recognises in some of the decorative designs of Assyria. It seems to be intimately associated with most of the weird fables that gravitate around the *Citrus*. The citron is best propagated by seeds or layers. Firminger alludes to the fruits being in Assam ripened within earthen jars before being removed from the tree. A similar practice may have originated the stories of citrons in the form of human faces, owing to the fruits having been grown within moulds of the desired form.

2. **Var. Limonum** or **Lemon.**—The word lemon comes from the Arabic *limún*, and through the Persian became the Hindi *limu, limbu or nimbu.* It is specifically known to the Indian people as the *pahari* (hill) *nimbu, karna* (or *korna*) *nebu, kimti, meta-limbu, thora-limbu,* and as the *kalambak* of Arabic and *kalínbak* of Persian.

The wild form of the lemon has not been recorded as met with in India—the plant mentioned by Royle, Madden and others was more probably the *lime* than the *lemon.* Lemons are, however, fairly extensively cultivated here and there all over India. Still, the true lemon is hardly one of the regularly grown fruits, in the gardens of the people generally, but rather of the well-to-do and the curious.

Sour Lime. 3. **Var. acida**; *Kew Bull.*, 1894, 113–6, 177–82 and pl.; the Sour Lime of India.—This is the lemon of most popular writers, and is undoubtedly a native of India. It is the true *nibu* or *nebu, nimbu, libu*, etc., and is the *jambiri* of Baber, the *jambira, limpáka, nimbuka, vijapura* and *vijaka* (according to Dutt) of the Sanskrit authors (Susruta (ed. Hessler), 1844, i., 86). This is the plant usually met with in a wild state in the warm valleys of the Himalaya. There are numerous cultivated forms of it, the two chief being a round lime (*páti-nembu*) and a long lime (*kághzi* (*kaguji*) *-nimbu* or thin-skinned *nebu*). The thin-skinned limes of Jaunpur and Azamghar are celebrated. Then there are in addition the *patí* or small round lime, the *gorá* or oval fruit, the *Chini-gora*, which much resembles an orange, the *kámuráli*, a very large lime, the *khatta* of Upper India, the Bajoura limes—a sort of citron-lemon, the *gungoli* and *Biharí* and many others.

Cultivation. The Sour Lime is easily reproduced by layers or seeds, the finer qualities being budded on the commoner and hardier wild stocks. The wild lime is, in fact, the chief budding stock for all species of orange, lemon or citron. The juice of this fruit is universally used for flavouring soups, curries, fish, etc., since it imparts a pleasant acid taste and agreeable flavour. It is also largely used in domestic medicine. The small sour limes are extensively employed for sherbets and in the manufacture of lime-juice, and the large ones made into various preserves. Baber refers to several forms of lime, so that we have abundant evidence that they have been known and valued in India for many centuries.

West Indies. In the West Indies the lime is specially grown in Montserrat, Dominica, Jamaica and Trinidad on account of the juice—the lime-juice of commerce. The reader will find a highly instructive paper on the West Indian Lime Industry, written by A. J. Brooks (*Journ. Roy. Hort. Soc.*, 1907, xxxii., 172–88). It will be found to deal with the following among other subjects of interest:—History, Cultivation, Pests, Fruiting, Essential Oil, Raw Juice, Concentrated Juice, Citrate of Lime, Green Limes, Improvement of the Lime, etc. Brooks informs us that "the juice is exported in its natural or 'raw' state, or as 'concentrated' juice, the latter being one of the chief sources of citric acid." There would seem no good reason why India might not participate in this trade.

Sweet Lime. 4. **Var. Limetta** or Sweet Lime of India—the *santara nibu, mitha-nibu, amritphal, elemitchum, thanbaya*, etc., and the *madhukarkatika* of Sanskrit.

Baber's Opinion. Wight regarded the sweet lime as indigenous to the Nilgiri hills. It was known to Baber, who apparently did not much appreciate sweet limes or sweet oranges. In the Turki copy of his *Memoirs* there is a footnote written by his son Humaiun to the effect that Baber's dislike to the *amratphal* was "a consequence of his having been long and much addicted to the use of strong drinks, whence he naturally did not like sweet things." It has, however, very little flavour except that of sweetness, but being in season in August to October, when oranges are not procurable, it is much appreciated by many persons as a cooling and refreshing fruit. But it seems highly likely that the sweet lime has by many writers been frequently confused with the bergamot or green orange. It is eaten fresh, or after being preserved or cooked.

Budding Stock. The sweet lime is very largely employed by the Delhi orange-growers as a stock on which to bud the *santara* orange, and this circumstance may to some extent account for the peculiar flavour of the best Delhi oranges.

Conclusion.—It has not been found possible to afford space for more than the merest outline of this subject. Details of cultivation, of the diseases to which the various species are liable, as well as of their respective industrial and medicinal uses, have had to be all but omitted (see **Vinegar**, p. 1110). Consult the *Pharmacographia Indica* for therapeutic facts, and for particulars regarding the perfumes, Gildemeister and Hoffmann's *Volatile Oils* (1900, 460–85); as also the admirable paper by Burgess and Child in the *Journal Society Chemical Industry* (December 1901).

Industrial Developments.

The cultivation of oranges, lemons, pomelos and limes of India, if organised on a more extended and systematic fashion than at present, would of necessity involve full advantage being taken of each and every profitable outlet, such as the preservation of the fruit (candied), the production of lime-juice, and the manufacture of perfumes and oils (citral, bergamot, neroli, etc., etc.). The "oil of lemon" is one of the chief industries of Sicily. The summer crop is exported as fresh fruit, the autumn or winter crop is manufactured locally into the juice and oil for which that island is famed. But it is regarded as very injurious to allow a tree to fruit twice a year, and hence the December crop is, as a rule, preferred. The lemon begins to yield when five years old. When fifteen to twenty years it gives 1,000 fruits, and when full grown may afford from 3,000 to 5,000. In the production of oil and juice, the fruit is cut into pieces, the pulp scooped out from these, the peel soaked in water for an hour or two, and then pressed by hand over a sponge in order to separate the oil. If candied peel is to be prepared, only half the oil is so expressed, otherwise as much as can be squeezed out is taken, and the waste peel given to cattle. The pulp is pressed for juice and the residue used as cattle food. Such is in brief the process usually adopted in the preparation of lemon oil and lemon juice in Sicily.

Oil of Lemon of Sicily.

Future Trade.

If an Indian industry were therefore organised, a large share in the profits of cultivation would have to be derived from these and other sources. Much care would have to be expended in selecting the best stock and in ascertaining if the lime, in place of the lemon, would meet all the necessities of trade. The lime would in all probability be better suited to the climate of most districts of India, but there exists a wide range of forms from which to select. To organise an export traffic in fresh fruit, it would be indispensable to have special shipping arrangements, since the fruit would be greatly injured if consigned to the hold along with mixed cargoes. Quick transit, careful packing, and good storage are essential to success. [*Cf. Kew Bull.*, 1892, 108; 1894, 114; 1895, 266–71.]

D.E.P., ii., 360–8.

Clays.

CLAYS, BRICKS, POTTERY, ETC.—Ceramic Art and Wares.—Montgomery Martin, *Hist. E. Ind.* (compiled from Buch.-Ham. *Repts.*), 1838, i., 347–9, 535–6; ii., 165, 167–72, 256–7, 948–55, pl. xiv.; iii., 208, 681; Mallett, *Rec. Geol. Surv. Ind.*, 1889, xxii., 139–48; Holland, *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 104. The *gil, chikni, chikita, matí, sangi-i-dalam, káli-munnu, tannab, krishna mirtika*, etc.

Sir T. H. Holland, Director of the Geological Survey of India, in his *Review of Mineral Production* (*l.c.* 104), observes that "no statistics approaching any degree of completeness are obtainable to show the extent of the undoubtedly great industrial value of the clays in India. They include the common clays used all over the country for the manufacture of bricks, tiles, and the cheaper forms of pottery; finer varieties. used for glazed pottery, which in places has obtained a reputation for artistic merit; fire-clays, raised in considerable quantities on some of the Gondwana coal-fields; and fuller's-earth, which is mined in the Central Provinces and in Rajputana." In these brief sentences Holland has furnished the chief kinds of clays met with in India. In the remarks that follow, these will be severally dealt with, except that, as a matter of convenience, the clays used for all kinds of pottery (unglazed, painted and glazed) will be taken up last instead of second:—

Bricks and Tiles.

History of European Production.

k and Tile Clays.—Until the middle of the last century it was thought necessary to import bricks from England, and that prejudice served to destroy the hopes of Mr. George Macdonald, who in 1866 became virtually the pioneer of European brick-making and pottery in India. He failed disastrously to interest the Government engineers and the building trade in the products of his factory at Raniganj (Raneegunge). In 1881 Mr. J. H. Glass directed attention to the Jabbalpur supplies, and as a consequence the Geological Department deputed Mallet to inquire into the clays of the Central Provinces, the result being that the claims of Umaria were urged very strongly. It was pointed out that Gondwana clays were abundant, coal and fire-clay on the spot, felspar obtainable within four miles, while chalcedony might be collected in the Mahanadi near Chandia. Messrs. Burn & Co. had meantime founded their potteries on the very spot where Macdonald failed. It is said they now turn out about 30,000 bricks a day, including glazed bricks for bathrooms, and blue-chequered damp-proof bricks for stores and godowns. And about the time of Mallet's report they extended their operations by opening out their Jabbalpur works.

Early India Production.

But bricks were used in India long before the arrival of the English, and some very old edifices, fortifications, etc., seem to have been constructed with large thin bricks not unlike those employed in ancient Europe. Such bricks were recently found, for example, by Dr. Stein in the ruins of the *stupas*, etc., of ancient Khotan, of a date of the 7th or 8th century. Abul Fazl, the chronicler of the Emperor Akbar's reign, mentions three kinds of bricks, "burnt, half-burnt, unburnt," and observes that the Emperor had fixed the price for these. The first kind, he adds, were usually made very heavy. [*Cf. Ain-i-Akbari*, 1590 (Blochmann, transl.), 1873, 223.] These three grades are met with to the present day all over India, and in fact most houses, garden walls, etc., of the peasants of India are mainly constructed (when bricks are used at all) of sun-dried bricks. But if Indian fired bricks have not hitherto borne a very high reputation for strength and durability, it has been upheld that the cause of inferiority should more often be sought in the process of manufacture than in the material used. A writer in *Indian Engineering* (August 4, 1900) pointed out that in making bricks by hand it was very difficult to get the edges sharp and well defined, the only way to obtain this being to use none but well-made moulds and to reject at once any mould found to be in the slightest degree cracked or damaged. That difficulty is to a large extent overcome by the use of machinery, though an even greater disadvantage at once arises, namely that machine-made bricks have to be transported from the brick-field to the building site, thus materially adding to their cost. In India it is usual to manufacture hand-made bricks near the place where they are to be used, and it is highly

Three Kinds.

Strength and Durability.

Machine-made.

likely, therefore, that the clay employed is not always the best that could be desired or discovered, were a search made a little farther afield. Finally, of course, the Indian climate is a very serious consideration.

Price.

With regard to Native-made bricks, interesting particulars have been published by Hoey (*Monog. Trade and Manuf. N. Ind.*, 1880, 162). He there observes that "good bricks of the size used in Government buildings are sold by the *puzawewala* at Rs. 7 per 1,000," whilst the "imperfectly burnt are called *tharra*, and sell at Rs. 4 per 1,000." Lucknow, of which Hoey was specially writing, is naturally a great brick-burning centre, owing to the lack of stone thereabouts. Ornamental bricks, moulded on the face with figures and patterns, were formerly made in many parts of Bengal. Good examples are to be seen in some of the temples in Chandernagore and Hughli, but more especially at the Kantanagar temple near Dinajpur. In North India, more especially in Lahore, carved bricks may be seen in the buildings of the well-to-do.

Moulded.

Calcutta.

It would seem likely, however, that the most important brick-making centre of India is the immediate neighbourhood of Calcutta. Tanks are dug that can, as desired, be flooded from the river. A deposit of fine clay is laid down and successive floodings are made till a workable bed of clay has been secured. Statistics are unfortunately not available as to the extent of production, but that the traffic is large can be judged by the fact that practically all the better-class houses of Calcutta are constructed entirely of brick. It is said that the largest brick factory in India is that of Akra, near Calcutta, which turns out 20 to 30 million bricks annually. The Calcutta bricks are, for the most part, fired by furnaces, not kilns. [*Cf. Min. Rev.*, 1898, 59.]

Tiles.

Tiles.—The firms concerned in the manufacture of bricks are also, in many cases, producers as well of tiles, pipes, etc. To a very large extent machine-made tiles, being lighter, better and more durable, are displacing the old heavy clay tiles made by village potters.

Brick and Tile Works

Brick and Tile Works.—It is sometimes affirmed, however, that the best tiles employed in India are still imported from Europe, the price being Rs. 15 per 100 (*Capital*, Oct. 15, 1903). In the S. Kanara district there were in 1894, 1,097 brick and tile burners and sellers; also eleven brick and tile factories in the town of Mangalore, eight being managed by Natives. Mr. Sturrock estimated the annual outturn of bricks at these factories to be 300,000, most of which are exported by sea to Bombay and other west-coast ports. The manufacturers sell the bricks at Rs. 35 per 1,000. [*Cf. Man. S. Kanara*, 1895, 143-5.] According to official statistics, the brick and tile works or factories throughout India employed in 1902, 6,255 persons; in 1903, 6,435; and in 1904 double the number, viz. 13,781. These figures are admittedly open to question since they can hardly include the Native brick-makers, but represent rather the personnel of the Brick, Tile and Pottery Works run on European methods, such as those at Raniganj, Jabbalpur, Aligarh, Bareilly, Mangalore, Feroke, etc. It may be mentioned that at the Raniganj potteries alone over 1,400 persons are employed, of whom about one-quarter are women engaged in porterage. The three tile works of the Basel Mission near Mangalore employed 540 hands in 1903, and the three works at Feroke, Malabar, 650 hands.

Persons Employed.

D.E.P., ii., 361-2.

Fuller's-earth.

Fuller's-earth, also Edible and Medicinal Clays.—There is little information of a recent nature on these materials. Rauwolf, who travelled in the East (in the middle of the 16th century), mentioned of Tripoli that an ash-coloured earth called *nalun* was employed for washing the head, and that another earth called *jusabar* was eaten by women. That sentence might be almost given as true of India to-day. A pale

Multáni Matti. yellow mud is eaten medicinally, and sold under the name *Multání mattí.* An earth known as *sang-i-basri* is said to be imported from Persia and used in tonic preparations, owing to the iron which it contains. Saucer-shaped chips of partially baked clay are sold in the Calcutta bazár for eating. Edible Earths. Montgomery Martin (*Hist. E. Ind.*, 1838, ii., 167) refers to a substance called *khari* eaten by women in Bengal. Hooper (*Rept. Labor. Ind. Mus.*, 1905-6, 37-8) gives particulars of 33 samples examined. Silica was the largest constituent, eight samples having 80, twelve 70, and six 60 per cent. The analysis showed that these clays had no food value. [*Cf.* Hooper and Mann, *Memoirs As. Soc. Beng.*, i., No. 12, 249-70.] It is probable that all these clays are nearly allied to fuller's-earth, which in India is employed as an external application to purify the hair and skin, in washing the cloths used in the manufacture of lac, indigo, etc., as also for weighting fabrics. Detergent. Weighting of Fabrics. It is interesting to add that the *Institutes of Manu* records the punishment to be meted out to manufacturers who add too great a weight to the textiles they produce. The following are said to be the best-known Indian sources of fuller's-earth—Colgong in the Bhagalpur Division of Bengal; the Central Provinces; the district near Kolath in Bikanir, Dera Ghazi Khan and Multan in the Panjáb. Holland says fuller's-earth is mined in the Central Provinces and in Rajputana.

Fire-clays.

Fire-clays.—These clays are capable of resisting a very high temperature without fusing or fissuring. They should be as nearly as possible free from lime, iron or alkaline earths, which promote the fusion of silica as in glass-making. In Europe the best clays for this purpose are found below coal-seams, and in spite of the different age of the Indian coal-fields, the underlying clays are found to be available for the production of a fairly good fire-brick material. Fire-bricks are manufactured in considerable quantities by Messrs. Burn & Co. at Raniganj, the clay being obtained locally. Promising fire-clays are also found at Jabbalpur, at Jowai in Assam, and at the Chanda, Umaria and Gondwana coal-fields. It is probable that with proper manipulation some of the pottery clays, not hitherto used for the purpose, would afford perfectly refractory materials.

Pipe-clay.

Pipe-clay (*namam, kharra,* etc.), so called in English from its being used for tobacco-pipes. It much resembles China-clay, but possesses more silica. Ball makes no mention of the existence of pipe-clay in India, but Moore (*Man. Trichinopoly*, 1878, 67) states that a fine bed of it occurs between Terani and Kárai. Pipe-clay has also been mentioned as a product of the Madras forests. [*Cf. Madras Man. Admin.*, 1885, i., 313.] An anonymous correspondent of *The Madras Weekly Mail* (April 20, 1905) stated that the clay used in the ornamental pottery of Karigeri in North Arcot was a form of pipe-clay.

Pottery-clays.

Pottery-clays.—The pottery-clays of India might be popularly assorted according to three degrees of purity, viz.:—(*a*) *kaolin,* China or porcelain clay; (*b*) ordinary white or glazed pottery clays; and (*c*) red or tile and flowerpot clays. The third has perhaps been sufficiently indicated above in connection with brick and tile clays, since most average good brick clays may be used for unglazed pottery. Kaolin. Kaolin, besides being employed for porcelain, is utilised in the paper and soap industries. It is sold in the form of large lumps of a white or yellowish-white

Paper-making.

colour. It fills up the pores of the paper and gives a smoother and more absorbent surface. [*Cf.* Cross and Bevan, *Paper-making*, 1900, 197.] It is formed by the gradual disintegration of felspar under the action of air and water, and consists essentially of a silicate of aluminium. Its quality depends upon its whiteness and freedom from the coarser micaceous particles. Although there is probably nowhere in India an occurrence of the finest porcelain-clay, such as that of the south-western counties of England, yet there are several districts where fine white clays exist and are utilised for pottery. In fact the chief districts where such clays occur are naturally more or less identical with the localities whence the Indian Art potteries are produced. The following brief statement may be useful :—

Ceramic Ware.

Potter's Position.

Painted Pottery.

Glazed Pottery.

Muhammadan Influence.

The *Kumhár* and the *Kuzagár.*

Indo-Saracenic.

Ceramic Ware.—There are three classes of pottery :—(*a*) Aboriginal work, (*b*) Hindu work, and (*c*) Muhammadan work. Ceremonial usage amongst the Hindus requires that pottery, whether polluted or not, shall be thrown away on certain specified occasions, so that there has arisen a large trade in a cheap material where artistic developments would be superfluous. So far as the production of this everyday domestic pottery is concerned, the potter will probably always hold an important position in village life. But even *he* is beginning to feel the stress of competition. Glazing is unnecessary unless the ware be meant to hold water, and since artistic ware has mainly been produced in the way of grain or pickle jars, painted or lacquered pottery is equally serviceable and infinitely cheaper than glazed ware. Indeed, with the exception of the few examples discovered in association with the Dravidians of South India and the fragments of old pottery found in the Charsada excavations near Peshawar, there is no reason to suppose that glazed earthenware vessels were at all used in India prior to the Muhammadan conquests. The former of the two exceptions possibly is suggestive of the origin of the apparently spontaneous art of glazing found at Vellore in North Arcot. Beyond the frontier of India, moreover, it has been recently shown by Stein (*Ancient Khotan*) that an advanced knowledge existed from perhaps the second century of our era. It is just possible, therefore, that the discoveries both in the south and north of India of old glazed pottery (and even of glass) indicate Buddhist rather than Hindu work. But that the glazed pottery of India, as generally accepted by European connoisseurs, began with the Muhammadan traffic in coloured tiles for mosques and tombs there can be no doubt. To this day the village potter (*kumhár*) is nearly always a Hindu, and he makes unglazed pottery, whilst the ceramic artist (*kuzagár. kashígár*) is ordinarily a Muhammadan (except in such rare and notable cases as that of the Hindu *kuzagárs* of Delhi). Moreover the *kuzagár* often purchases from the village potter sun-dried vessels which he afterwards ornaments and fires. It is a matter of everyday knowledge that the glazed vessels of recent times, so eagerly purchased by visitors to India, are but special adaptations gladly pursued by the Indian craftsmen with the decadence of the demand for tiles. In any case all present-day glazed pottery in India (except perhaps the Vellore work) is Indo-Saracenic in design, is made by Muhammadans, and sold exclusively to Muhammadans or Christians. Mr. Hughes Buller and Mr. Gupte recently discovered a kiln and rude contrivance for making pottery in Baluchistan, which seemed to have been used for making glazed-ware, since fragments of such pottery were found near by. Mr. Buller is of opinion that the fragments in question are Persian in technique, a view supported by the circumstance that there are no records of an indigenous Indian glazing art in Baluchistan.

Deterioration.

The modern demand for cheap Indian work is rapidly causing a deterioration from the original tile models of former times. Fortunately the shapes of the unglazed and painted wares, platters, cooking-pots, water-jars, etc., are as yet uncontaminated by foreign demands and hence remain graceful and well worthy of study, alike by the antiquary and the artist.

[*Cf.* Birdwood, *Indust. Arts Ind.*, 1884, 387–418 ; Mukharji, *Art Manuf. Ind.*, 1888, 283–93 ; *Journ. Ind. Art*, 1885, Nos. 9 and 10 ; 1886, Nos. 12, 14, 16 ; 1887, Nos. 17, 19, 20 ; 1888, Nos. 23, 24 ; 1889, No. 28 ; 1890, No. 29 ; 1891, No. 33 ; 1892, Nos. 41, 42 ; 1894, No. 52 ; 1895, Nos. 55, 57, 58 ; 1897. No. 45 ; *Monographs, Pottery and Glassware* :—T. N. Mukharji, *Bengal*, 1895 ; Maconochie, *Bombay*, 1895 ; Dobbs, *United Prov.*, 1895 ; Taw Sein-Ko, *Burma*, 1894–5 ; Watt, *Ind. Art at Delhi*, 1903, 80–98, pl. 20 (*a*).]

Import Trade.

Contributing Countries.

Receiving Provinces.

Trade.—The value of the *EARTHENWARE* and *PORCELAIN* (excluding earthenware piping) imported in 1899–1900 was Rs. 19,90,369, but it rose in the succeeding years, until in 1903–4 it reached Rs. 28,00,038, and in 1906–7 Rs. 38,99,824. The United Kingdom usually supplies 50 per cent., whilst Belgium, Germany and the Straits Settlements contribute between them about 40 per cent. The chief receiving provinces in 1906–7 were Bengal, Bombay and Burma, which took respectively quantities valued at Rs. 14,22,977, Rs. 12,27,104, and Rs. 8,93,767. A small proportion (Rs. 2,58,929 in 1906–7) was re-exported and sent to Persia, Arabia, the United Kingdom, Turkey-in-Asia, East Africa, etc. *EARTHENWARE PIPING* (which is mentioned separately in official statistics) is imported from the United Kingdom, and in 1906–7 amounted to 31,347 cwt. (Rs. 2,16,808), most of it being received by Bombay. *BRICKS AND TILES* are taken by India, principally from the United Kingdom and into Bombay.

Imports.

Both in quantity and value the imports increased by more than 100 per cent. during the five years ending 1903–4. In the first year of that series they were in number 3,641,594, valued at Rs. 2,11,255, and in 1903–4 they were 7,135,872, valued at Rs. 5,16,610. Since then they have continued to increase to 14,922,191 (Rs. 10,64,560) in 1906–7. India also imports a small quantity of *CLAY*. The amount in 1906–7 was 56,889 cwt., valued at Rs. 96,557, and the country chiefly concerned may be said to be the United Kingdom, the supply being consigned to Bombay, Bengal and Burma.

Exports.

The total value of Indian *EARTHENWARE* (except piping) exported in 1906–7 was only Rs. 44,709, consisting of certain small consignments from Madras, Bombay and Bengal to Ceylon and the United Kingdom. *EARTHENWARE PIPING*, not included in the above, is exported chiefly from Bengal to the Straits Settlements. The amount in 1906–7 was 7,690 cwt. (Rs. 34,368). The exports of Indian bricks and tiles go principally from Madras to Ceylon. In 1899–1900 they were valued at Rs. 68,797, and in 1906–7, Rs. 1,03,314.

D.E.P., ii., 378–95.
Coal.

COAL.—Ball, *Man. Econ. Geol. Ind.*, 1881, 59–119, 592–604 ; *Mem. and Rec. Geol. Surv. Ind. for past* 20 *years* : Watt, *Rev. Min. Prod. Ind.*, 1894 *to* 1897 ; Dunstan, *Coal Res. Ind.*, in *Journ. Soc. Arts*, Feb. 1902 ; *Imp. Inst. Tech. Repts.*, 1903, 319–77 ; also *Rec. Geol. Surv. Ind.*, 1906, xxxiii., 241 ; Holland, *Rev. Min. Prod. Ind.*, 1898–1903, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., 17–45 ; 1907, xxxvi., 66–71 ; *Stat. Min. Prod. Ind.*, 1890 *to* 1904, etc. etc. The *koyelah, koyala, koelo, kolsa, kari, simai-karri, boggu, sima boggu, iddallu, misu-e, midu-ye*, etc.

History.

First Licence issued in England.

Supremacy of Newcastle.

History.—Coal has doubtless been known to the Natives from time immemorial, but was neither mined nor traded in until sought out by the early European residents in India. Even at the present date it is little if at all used in the purely indigenous industries, and hardly ever employed for domestic purposes. But this state of affairs is perhaps little to be surprised at when it is recollected that the first licence to dig for coal in England was granted by Henry III. in 1239: it was then designated "sea-coal." In 1306 the use of coal in London was prohibited, but in 1325 a trade had been organised between England and France in which coal was exported and grain imported. About this time also Newcastle became famous for its coal, and for a couple of centuries at least fleets of ships sailed from thence to supply London and the other ports of England, as also France, Holland and Germany. It would be beyond the scope of this article to follow the growth of the European knowledge in coal or to narrate the discovery of the other coal-deposits that finally overthrew the supremacy of Newcastle. By 1776 we read that Sunderland, Blyth, Hartley, Durham and several other centres in both England and Scotland had commenced to export coal independently of Newcastle and of the charters granted to the original seat of the trade. It was only natural, therefore, that the European residents in India, in the middle of the 18th century, should have begun to think of a possible Indian supply of an article that had been proved of so great value in their home countries.

First Indian Licence.

Influence of Lord Cornwallis.

Heavy Charges through Coal Indents.

Earl Minto's Action.

Marquis of Hastings.

Calcutta Merchant.

In 1774 Warren Hastings granted a mining license to two of the Company's servants, namely Mr. Suetonius Grant Heatly and Mr. John Sumner. The former gentleman, we learn, had discovered coal in "the districts of Bheerbhoom and Pachete." Mr. Heatly (son of the discoverer and original worker of the Bengal mines) tells the story of his father's labours, in an article which will be found in the *Journal of the Asiatic Society of Bengal* (1842, xi., 811–35). Unfortunately the coal Heatly produced was reported as being much inferior to that of England, and this circumstance, together with the indifference of Lord Cornwallis to measures calculated to develop the internal resources or promote the external commerce of India, led (according to Heatly, junior) to the neglect and apathy that characterised the first few years of coal-mining in India. In 1777 Farquhar and Motte asked permission "to bore cannon and to cast shot and shell in the district of Jherria, lying between the rivers Dummuda and Burraker." They gave as their reason for the selection of that locality that it "abounds in iron ore and is contiguous to the coal-mines of Messrs. Sumner & Heatly." Williamson (*Wild Sports in the East*, 1808, i., 7, 8) alludes to Indian coal, but remarks that the Company "finds it easier to send coal from England, as ballast, to their arsenals abroad, where quantities are occasionally used in fusing metals for casting ordnances." But apparently about this very time the London Directors of the East India Company had actually complained of the heavy charges involved by the indents for the coal made by their Indian representatives, and they accordingly recommended an inquiry whether charcoal could not be substituted; and if not, they further recommended the transference of the ordnance works to England. The Earl of Minto was at the time Governor-General of India, and to his enlightened action may be attributed the birth of the present prosperous trade in coal. He directed that Indian coal should be submitted to actual tests by the military authorities in India. Col. Hardwicke accordingly performed experiments but reported once more very unfavourably (dated May 19, 1809), and the subject of coal for a time dropped out of notice. But in 1814 the Marquis of Hastings once more urged on the Military Board the desirability of ascertaining beyond doubt "whether the coal of India was of a quality calculated for the purpose of the forge." His lordship announced that a fully qualified person would be appointed to examine the mines, who would be furnished with the necessary apparatus to make borings and who would for experimental purposes procure a supply of coal from such a depth as to ensure that it would represent the average quality. Previous experiments were thus discredited owing to the coal used having been obtained from the surface and therefore much deteriorated. By this time we hear of a Calcutta merchant having commenced to use Bengal coal, notwithstanding the unfavourable reports published by the Military Board. Coal was, in fact, being regularly conveyed by boat down the Damuda river to Calcutta, and it is therefore not to be wondered at that

Expert Report.

Indian used for burning Sylhet Lime.

the Viceroy should have once more called for a thorough inquiry. Mr. Rupert Jones accordingly went from England on purpose to examine the Bengal coalfields, and his report (written in 1815) will be found in the *Asiatik Researches* (1833, xviii., 163–70). Needless to say this gave new life to the Indian mines and proved that indifference and obstruction to the use of a new material had more to say to the unfavourable opinions previously published than the actual inferiority of the coal—at least for many of the purposes for which English coal was being imported. But in passing it may be added that Mr. Jones himself did not realise the full value of his investigations. He foretold increased prosperity to Calcutta, through the coal he had discovered being a better and more economical fuel for burning the Sylhet limestone than the firewood then in use. Jones apparently knew little of the great revolution steam was destined to effect, nor of the imperative necessity of an abundant and cheap supply of coal for commercial and industrial prosperity.

First Indian Company, 1820.

Jute Mills.

Production in 1857–8.

Coal-mining Assured.

Rolling Stock

Mines.

Raniganj.

Jherria.

Giridih.

Imports Shrinking.

Exports.

India's Position in the World's Supply.

Indian Coal the Cheapest in the World.

Mr. Jones received an advance from Government of £4,000, on easy terms, to enable him to work the mines, but in 1820 he came utterly to grief. Fortunately a number of Calcutta firms stepped into the breach. The first regularly constituted Indian mine under European supervision and capital was opened in Bengal in 1820 (Raniganj mine). In 1839 the output was 36,000 tons. Still, little progress was made till the construction of the East Indian Railway in 1854 tapped the coalfields. But even then the progress was but slow until the jute mills of Calcutta had been started and the other directions of manufacturing skill originated, that gave vitality to the Eastern capital. Apparently 1857–8 was the first year of specially recorded production, when 293,443 tons were taken from the Indian mines and 92,983 tons imported. From that date the prosperity of coal-mining was assured. It became the direct expression of a rapidly expanding modern commerce. This may be briefly exemplified. In 1868 the output was 459,408 tons; in 1878, 925,494 tons; in 1898, 4,608,196 tons; in 1904, 8,348,561 tons; and in 1906, 9,783,250 tons. Of these the Bengal mines supplied 88 per cent. [*Cf. Moral and Mat. Prog. Ind.*, 1905–6, 114.] One of the difficulties experienced in this remarkable trade has been for the railways to keep pace in the supply of the rolling stock necessary. In 1885 there were 95 mines, of which 90 were in Bengal; in 1900 there were 286 coal-mines in operation, of which 271 were in Bengal; in 1906 there were 307, of which 274 were in Bengal. The number of mines only partially represents progress, on account of the tendency for small mines to be grouped together as a smaller number of large ones. The greatest development has taken place in the Raniganj field, owing to the collieries being only 120 to 140 miles from Calcutta. Jherria, some 40 miles more distant, has recently given evidence of having very likely permanently overtaken Raniganj. But no less vigorously have the Giridih fields been pushed forward. It can now be affirmed that India is rapidly approaching the state of being able to meet all her own wants for fuel. The imports have been shrinking steadily for years, and in 1903–4 were one-fourth of the quantity taken nine years previously. And of these imports Bombay—a province remote from the Indian mines—consumes by far the major portion, viz. 148,311 tons out of a total of 179,935 tons in 1905–6. England, Australia and Japan are the supplying countries. But a new trade has arisen, namely in coal exported to Indian Ocean ports—a traffic that it would seem is instantly stimulated and permanently strengthened by the strikes and other accidental causes which in Europe and Japan tend to raise the price of coal. A vivid conception of the present magnitude and importance of the Indian coal industry may be had from the circumstance that in 1903 the output came to 7½ million tons, while the outputs of both Canada and Australia were each just under 7 million tons; and the Indian production has since risen to almost 10 million tons. But a still more significant fact may be added in conclusion, namely that Indian coal is the cheapest in the world. The average pitmouth price was in 1902, Rs. 2–12 (3*s.* 8*d.*) and in 1906 Rs. 2–15 (3*s.* 11*d.*) per ton, while in the United States the corresponding average price was 5*s.* 8¼*d.*; in Australia 7*s.* 9*d.*; in the United Kingdom 8*s.* 2¾*d.*; in Germany 8*s.* 10¼*d.*; in Canada 9*s.* 3*d.*; and in New Zealand 10*s.* 0*d.* An interesting series of articles on "Dear Coal" will be found in *The Textile Journal* (May, July and December, 1900).

The annual reports, etc., of the Indian Mining Association and those of the Bengal Chamber of Commerce are usually of the greatest interest and value in setting forth the progress or the disabilities of the mining industry. But it

Silence of Early Travellers.

may be added that none of the early European travellers in India make any mention of coal, prior to the first decade of the 19th century. This is abundantly exemplified by the silence of Milburn (*Or. Comm.*, 1813) and of Macpherson (*Hist. Europ. Comm. Ind.*, 1812), two authors who were certain to have had chapters on Indian coal and India's requirements in coal had these been questions of public importance at the time in which they wrote.

OCCURRENCE AND DISTRIBUTION OF COAL IN INDIA.

India's Coal Resources.

Holland (*Rev. Min. Prod. Ind.*, 1905, 1907) has furnished so comprehensive a statement of India's coal resources that it is hardly necessary to do more than give an abstract of his opinions in order to bring the *Dictionary* up to date. He confines attention to the coalfields actually being worked or those likely to be worked in the near future. The particulars that follow in this chapter are, therefore, derived very largely from Holland's instructive and practical Reviews :—

" Most of the coal raised has been obtained from the Gondwana system of strata in Peninsular India, where the coal-mines, being nearer the coast and generally within touch of the main railway lines, have been developed more rapidly than those of the extra-Peninsular Cretaceous and Tertiary coal-beds." The Gondwana mines furnished in 1906, 95·56 per cent. of the total supply. It may be useful to exhibit the chief groups of mines categorically :—

Raniganj and Jherria Coalfields.

(*A*) ***GONDWANA COALFIELDS.***—1. ***Raniganj and Jherria in Bengal.***—Raniganj was the first to be developed and formerly had the largest output, but since 1906 the lead has been taken by the Jherria mines farther west in the Damuda valley. These mines are tapped by the E.I.R. and by the B.N.R. systems. " The coal from the Raniganj field is mainly derived from seams in the highest beds of the Damuda series, the lowest, or Barakar stage, being less developed in the exposures along the northern margin of the field. In the Jherria field the converse is the case : the uppermost stage has yielded poor coal, whilst in the Barakar series there are some eighteen well defined seams of which the upper eight include enormous supplies of good coal. The two classes of coal present a well-marked and constant difference in the amount of moisture they contain : the older, Barakar, coals, both in the Raniganj field and in Jherria, contain on an average about 1 per cent. of moisture, whilst the average for the younger coal of the Raniganj series is 3·8 per cent. in the lower seams, and nearly 7 per cent. in the upper seams. There is a corresponding, but less marked, difference in the proportion of volatile hydrocarbons, which form a larger percentage of the younger coals than of those at lower stages in the Damuda series."

Amount of Moisture.

Giridih.

2. ***Giridih in Bengal.***—" The small patch of coal-bearing Gondwana rocks near Giridih is practically divided between the Bengal Coal and the East Indian Railway Companies. The chief wealth of the field is stored in a 15-foot seam of good steam and coking coal near the base of the Damuda series." It has been estimated that the remaining workable supplies probably do not exceed 77 million tons. [*Cf.* Saise, *Giridih Coal Fields and Notes on Methods of Working*, in *Rec. Geol. Surv. Ind.*, 1894, xxvii., 86–100.]

3. ***Pench Valley in the Central Provinces.***—An interesting development is the opening out of the Pench supplies. In 1905 the production was 1,104 tons, and in 1906, 32,102—in spite (adds Holland) of the imperfect railway facilities. This field is of special value to the mills of Bombay and the Deccan.

Mohpani.

4. ***Mohpani in the Narsinghpur District of the Central Provinces.***—This colliery has been worked since 1862 by the Nerbudda Coal and Iron Company. It has made little progress, but a new area some two miles farther west has been discovered and operations commenced. Medlicott published in 1872 a paper entitled *Notes on the Satpura Coal-basin* that should be consulted regarding the coal of this area. More recently Mr. C. J. Dalby of the Bengal-Nagpur Railway submitted in 1892 a report on the Rampur Coalfield. Also Mr. G. F. Reader, Mining Specialist, published (*Mem. Geol. Surv. Ind.*, 1901, xxxii.) a more detailed account of these fields.

Warora.

Spontaneous Combustion.

Future Mines.

5. ***Warora in the Chanda District of the Central Provinces,*** and about 62 miles south of Nagpur, has been worked since 1871 by the State. About half the coal raised is taken by the G.I.P. Railway, the rest going to the cotton-mills and factories of the Central Provinces. This coal is liable to spontaneous combustion, and a large part of the field has been lost through fire. "The Warora colliery has been worked under distinctly greater natural difficulties than those usually met with in Bengal." "The returns for labour at Warora, notwithstanding the difficulties arising from water and liability to spontaneous combustion, show that the system of mining adopted permits of a satisfactory output per person employed, whilst the deaths due to accidents have been reduced to a low rate." "Another three or four years will probably see the end of the Warora colliery, but, with the extension of the Wardha Valley line southwards, the extensive deposits near Bellarpur will be opened up." Prospecting operations have recently commenced on the known thick coal-seams in the Wun district, Berar. These coal-fields are fully described by Hughes. [*Cf. Mem. Geol., l.c.* xiii., 1.]

Singareni.

Heavy Loss of Life.

6. ***Singareni in the Nizam's Dominions.***—"The great belt of Gondwana rocks near the north-west end of which Warora is situated stretches down the Godavari valley as far as Rajamundry, and at one or two places the equivalents of the coal-bearing Damuda series in Bengal are found cropping up from below the Upper Gondwana rocks. One of these occurrences near Yellandu in the Nizam's Dominions forms the coal-field well known by the name of Singareni. The principal seam of coal, some 5 to 6 feet thick, being worked at the Singareni colliery was discovered by the late Dr. W. King of the Geological Survey in 1872, but mining operations were not commenced until 1886." "Coal-mining at Singareni has been accompanied by a heavier loss of life by accidents than in the general run of Gondwana fields." The opinion seems upheld that for steam purposes Singareni coal is considerably inferior to Bengal coal and is not a coking coal. These circumstances would seem largely to account for the slow progress made with this coal in South India. The Reports of the Hyderabad (Deccan) Company, Ltd., afford useful particulars regarding the mine.

Umaria.

7. ***Umaria, Rewah State, Central India.***—The Bilaspur-Katni Branch of the Bengal-Nagpur Railway passes through this small coalfield. "The quantity of workable coal in this field is estimated at about 24 million tons." "The four coal-seams being worked vary from 3 to 12 feet in thickness and dip about 4° to the north-east. The mines were opened in 1882 under the direction of Mr. T. W. H. Hughes of the Geological Survey and were controlled by Government until the 1st of January, 1900, when they were handed over to the Rewah State." Most of the

coal raised is sold to the Indian Midland and to the Bengal-Nagpur Railways. [*Cf. Ann. Repts. Rewah State Collieries*, 1899–1903.]

Younger Coal.

(B) CRETACEOUS AND TERTIARY COALFIELDS.—" The younger coals are nearly all of Cretaceous and Tertiary age, although some thin and poor seams of Upper Jurassic coal have been worked in Kach. The Cretaceous beds occur in the Khasia and Garo hills of Assam, where they are found in small basins resting on the Archæan schists and gneisses. The Cretaceous coals of Assam are generally distinguished by the inclusion in them of nests of fossil resin, and this character was noticed in the coal recently discovered to the north of Shillong."

" Coal of Tertiary age is found in Sind, Rajputana, Baluchistan and along the foothills of the Himalaya, further east in Assam, in Burma, and in the Andaman and Nicobar Islands. The most frequent occurrence is in association with nummulitic limestones, though the richest deposits, namely those in North-East Assam, are younger, probably Miocene in age. Of these extra-Peninsular fields, the only ones producing coal are of Tertiary age."

" On the whole, the younger coals, which are being worked in extra-Peninsular areas, differ from the Gondwana coals in containing a larger proportion of moisture and volatile hydrocarbons, and though as variable in composition as they are in thickness of seam, coals are obtained, as for instance in Assam, with a remarkably low percentage of ash, and having a high calorific value."

Makum.

8. ***Makum in North-East Assam.***—This is being worked by the Assam Railways and Trading Company, who commenced operations in 1881. " The collieries are connected by a metre-gauge railway with Dibrugarh on the Brahmaputra river, which, being navigable, forms both a market and a means of transport for the coal. The most valuable seams occur between the Tirap and Namdang streams, where, for a distance of about five miles, the seams vary from 15 to 75 feet in thickness. The average dip is 40°, but as the outcrops in many places are several hundred feet above the plains, facilities exist for working the coal by adit levels." " The coal has the reputation of being a good fuel, and forms an excellent coke." [*Cf.* Mallet, *Coal Fields Naga Hills, Assam*, in *Mem. Geol. Surv. Ind.*, 1876, xii.; La Touche, *Coal Fields Jaintia Hills*, 1889; Bose, *Rept. on Um-Rileng Coal-beds, Assam*, in *Rec. Geol. Surv. Ind.*, 1904, xxxi.; A.R.T.C., Ltd., *Ann. Repts.*, Nos. 1–21.]

Burma.

9. ***Shwebo District in Burma.***—Coal occurs in various parts of Burma. Within the past few years it has, for example, been definitely ascertained that in the Nammaw field (30 miles from the Mandalay-Lashio Railway) there are seams of lignitic coal 10 feet thick. [*Cf.* Jones, *Notes on Coal, Upper Burma*, in *Rec. Geol. Surv. Ind.*, 1887, xx., 170–93; Noetling, *Upper Chindwin Coal-fields*, 1890; Primrose, *Rept. Prosp. Oper. in Tenasserim*, 1891-2; Bose, *Notes on Geol. Tenasserim Valley*, in *Rec. Geol. Surv. Ind.*, 1893, xxvi., 148–64; George Scott, *Upper Burma Gaz.*, ii., pt. 1., 230–8; Nisbet, *Burma Under Brit. Rule and Before*, 1901, i., 389–92.]

Baluchistan.

10. ***Baluchistan.***—Possibly the most important coal-deposits of the west are those in Baluchistan, where, however, the disturbed state of the rocks makes mining difficult, expensive and dangerous. The best mines are those of Sor (south-east of Quetta), the Bolan and Khost. From the last-mentioned mine the output in 1906 amounted to 32,500 tons.

Dandot.

11. ***Dandot in the Jhelum District of the Panjáb.***—The Dandot

plateau of the Salt Range. The only valuable seam varies in thickness from 18 to 39 inches and forms a basin under the nummulitic limestone. The mines have been worked by the North-Western Railway since 1884. [*Cf.* N.W.R., *Ann Rept. Working Mines*, 1896–1903.]

12. ***Bhaganwala.***—At the eastern end of the Salt Range—a seam of variable thickness also worked by the N.W.R. [*Cf.* Baden-Powell, *Pb. Prod.*, 1868, i., 27-34; Morris, *Hazara Coal*, 1889; La Touche, *Bhaganwala Coal Fields*, *Rec. Geol. Surv. Ind.*, 1894, xxvii.]

13. ***Mianwali District***, about two miles north of Kalabagh. This is classed as Jurassic coal, but so far regular mining has not been started. More promising Tertiary coal occurs at Maidan, 24 miles further west. [*Cf.* Simpson, *Rept. on Coal, Is Khel*, in *Rec. Geol. Surv. Ind.*, 1904, xxxi.]

14. ***Kashmir.***—The Jammu Coalfields—Tertiary; commenced to be worked in 1903. Washed and briquetted Ladda coal would be nearly as valuable as Bengal coal, but could not compete in price. [*Cf.* La Touche, *l.c.* xxi., 188; Simpson, *Mem. Geol. Surv. Ind.*, 1904, xxxii.]

Bikanir.

15. ***Bikanir in Rajputana.***—A lignite of dark-brown colour, with included lumps of fossil resin, occurs in association with nummulitic rocks at Palana in the Bikanir State. In 1898 mining operations were commenced at a point where the seam was found to be 20 feet thick. "The physical characters of the natural fuel form a drawback to its use in locomotives, but experiments recently made are said to show that satisfactory briquettes can be made in which the proportion of moisture is reduced, and the fuel made less vulnerable to atmospheric action." The proximity to railway demands seems likely to counterbalance the inferiority of this coal, of which the output in 1906 amounted to 32,372 tons.

Labour.

WORKING OF MINES: Labour, etc.—Holland may be still further placed under contribution: "Coal-mining in India, from the point of view of labour, is quite ahead of all other forms of mining. The number of persons employed daily has averaged 84,805 for the years 1898 to 1903." During 1904 the number rose to 92,740, of which 75,749 were employed at the Bengal mines. The Bengal coal-mines thus took 81·7 per cent. of the total labour supply. "It will not be surprising to those who know the habits of the Indian coal-miner to learn that the output per person employed is lower than in any other part of the British Empire except in Cape Colony, where cheap Native labour is largely employed. During the years 1901 and 1902 the outputs of coal per person employed in Indian mines were respectively 70 and 75 tons, whilst for the rest of the British Empire the corresponding figures were 281 and 285 tons." "An important consideration, naturally, in every mining community is the risk of life involved in the occupation. As far as coal-mining is concerned in India, the industry, so far as it has progressed, has shown not only a very low death-rate from isolated accidents, but also a noteworthy freedom from disasters, which in European countries have done more perhaps than statistics to force special legislation for the protection of workers in 'dangerous' occupations." "The average death-rate from such accidents has been 0·88 per thousand employed, while the average for the rest of the British Empire comes to 1·54 per thousand—in the U.K. 1·24." But if the death-rate be expressed to the tonnage of coal raised, India is shown up in a much less favourable light. New Zealand heads the list of successful mining from this standpoint with 1·47 persons killed per one million tons of coal raised in 1902; Queensland 1·99; Nova

Output per Person.

Death-rate.

Expressed to Tonnage.

Scotia 4·35 ; United Kingdom 4·42 ; Victoria 4·44 ; India 10·23 ; Transvaal 14·47 ; New South Wales 17·67 ; Cape Colony 24·16 ; Natal 26·99 ; and British Columbia 99·48. India is thus by no means the country in the British Empire that shows the worst result.

Indian System of Mining.

" The almost universal practice in Indian coal-mines is to extract the coal on the system variously known as the " bord and pillar," " post and stall," or " stoop and room " system. Although this system in Europe is fast being superseded by the more economical " long-wall " method, yet, owing to the thickness of most of the Indian seams, it is not easy to devise any more suitable plan of working. It is undoubtedly wasteful, for the pillars form from 25 to 65 per cent. of the available coal, and at the present time except in certain mines, where local-trained labour and efficient supervision are possible, their extraction is not even contemplated."

Mr. Ward's Method.

Holland points out that the strong roof in the Gondwana rocks, the freedom from disturbances, and the comparative lightness of the overburden are features of strength and safety not fully appreciated by those who have gained their experience in countries where these advantages do not prevail. In the Giridih coalfield the system of working thick seams there pursued, which is a modification of the South Staffordshire method suggested by Mr. T. H. Ward, allows of 90 per cent. of the coal being removed. Adamson (*Trans. Min. and Mech. Engin.*, 1903, lii., 202) has described fully the " working of a thick coal-seam in Bengal." " In the Makum field a highly inclined seam, 75 feet thick, is worked also on a modification of the South Staffordshire system of 'square work.' The coal is removed in two, or sometimes three sections, the top section being removed first, and a parting of stone and coal being left untouched between each pair of sections. In the Dandot and Khost mines, thin seams are worked in one operation, on a modified ' long-wall ' system."

Properties.

D.E.P., ii., 379.

Excess of Ash

PROPERTIES AND USES.—It is difficult, if not impossible, to give a general statement of the properties of Indian coal : the two great geological groups already established differ in almost every essential, and, moreover, the coal varies not only between mines within the same formation but even within the seams of one and the same mine. Averages are therefore often very misleading. The late Mr. H. B. Medlicott accordingly very rightly observed, " In both regions the quality of the coal varies much, as in all coal-measures ; but the best in both reaches a very high standard, almost if not quite up to that of high-class English coals. In the Gondwana (Bengal) coal the general defect is an excess of ash, and also in some an excess of moisture ; while in the Tertiary (Assam) coal the percentage of ash is low, but that of the volatile combustible matter high, producing a lighter fuel." Medlicott then furnished a table to show the results of various chemical examinations, and, as little of material importance has since been learned, it may be here reproduced :—

	BENGAL.			
	Average.	Best.	Average.	Best.
Fixed Carbon	53·20	66·52	56·5	66·1
Volatile exclusive of moisture	25·83	28·12	34·6	33·5
Moisture	4·8	0·96	5·0	—
Ash	16·17	4·40	3·9	0·4
	100·00	100·00	100·00	100·0

These average results, so far as averages go, will be found sufficiently near the truth for all practical purposes.

Moisture.

Volatile Hydrocarbons.

The moisture and the ash are the chief detractive features of coal. "Dr. Saise (*Rec. Geol. Surv. Ind.*, 1904, xxxi., 104–7) calls attention, however, to the remarkably constant differences in the percentages of moisture held by coals from the different geological horizons in the fields. In the case of the Barakar stage, which is the lowest in the series, the moisture amounts to only 1 per cent., while in the lower seams of the Raniganj stage it averages 3·81 and in the upper seams 6·86 per cent. There is a parallel but less pronounced variation in the amount of volatile hydrocarbons : in coal from the Barakar stage the average is 26·57 per cent. ; in the lower seams of the Raniganj stage it is 31·70, and in the upper seams 32·22 per cent."

In the *Records of the Geological Survey of India* (1904, xxxi., 237-9) will be found certain results of the coal and coke assays made by Mr. E. P. Martin and Prof. H. Louis at the instance of the Right Hon. Sir E. Cassel, on carefully procured samples from the Jherria and Raniganj fields. It is explained that the samples reported on had been taken from across the entire working face of the seam, and were not picked from a promiscuous pile at the pit mouth or taken from a particular part of the seam. Space cannot be afforded to republish the tables in the original form in which they appeared, but the following averages of the returns may be here

	Fixed Carbon.	Volatile Matter.	Sulphur.	Ash.	Moisture.	Lb. of Water evap. by 1 lb. of Coal.
Jherria Field .. (12 samples)	60·5	22·0	0·55	16·49	1·0	12·71
Raniganj .. (4 samples)	52·31	31·43	0·47	14·10	1·68	12·88

	Carbon.	Sulphur.	Phosphorus.	Ash.	Moisture.
Jherria Coke .. (9 samples)	75·16	0·65	0·17	24·64	0·48

Moisture.

Commenting on these results, Holland observes: "The beds in which the coal is now being mined in the Jherria field were long ago correlated by the Geological Survey with the Barakar series of the Raniganj coal-field, and it is interesting to notice that the low percentage of moisture recorded by Saise in the coal of the Barakar series in the Raniganj field is characteristic also of the Barakar coal in the Jherria field. In the case of the Barakar coal from the Raniganj field the moisture amounted on an average to 1·0 per cent., whilst in the case of these Jherria coals the average for moisture is 0·90 per cent."

A comprehensive report on the composition and quality of Indian coals, by Dunstan, will be found in the *Records of the Geological Survey of India* (*l.c.* 1906), where complete analyses of coal from all fields above mentioned (excepting those recently opened) are recorded.

Evaporation Water to Co Consumed.

In a recent practical experiment conducted with Seebpore coal at the National Jute Mills, Calcutta, by Mr. F. Grover of Leeds, it was found that that particular coal would evaporate 7·97 lb. of water, equivalent, had certain conditions obtainable in England prevailed, to 8·5 lb. The corresponding efficiency of the best Cardiff coal, it is believed, is but 9 lb. This result has been hailed by certain Indian newspapers as a new discovery of the greatest public interest and value, and one which refutes completely the unfavourable opinions often upheld regarding Indian coal in general. From the remarks already made it may have been inferred that for many years past it has been recognised that the finest Indian coals are little inferior to the best English and Welsh. But laboratory results are theoretical more than practical, and Mr. Grover's experiments are therefore of considerable importance. He has shown, for example, that the assays revealed the percentage of ash to be 11·5, while in the practical tests it came to 16·7 of the original weight. This is the expression of the practical difficulty of firing, and similar instances exist in other directions without invalidating the relative values of chemical assays. But so important is this question of ash that, as pointed out by Grover, a sample of coal could be carried 54 miles farther than another with which it was compared without exceeding the cost per ton of its combustible constituents.

Practical Difficulty of Firing.

Production.

TRADE.—Production and Supply.—In 1883 there were but two localities of Indian coal-production, viz. Bengal and the Central Provinces, and the total output from the mines in these provinces came to only 1,315,976 tons. Ten years later there were nine Indian centres of production (Burma, Assam, Bengal, Central India, Panjáb, Baluchistan, Central Provinces, Nizam's Dominions and Madras) and the output had been doubled (2,562,001 tons valued at Rs. 86,20,278). Still ten years later (1903) there were ten centres of production (Madras had disappeared and Kashmir and Bikanir had been added), but the output increased to 7,438,386 tons, valued at Rs. 1,94,95,741. These figures speak volumes for the mining enterprise of India, but the low price obtained (3*s.* 8*d.* per ton at the pit mouth in 1903) probably indicated that until the metallurgical industries have developed into important consumers of coal, present production may be viewed as approaching the limits of demand. But a hopeful sign of the suitability of Indian coal for all ordinary industrial purposes is the downward course of the imports of foreign and the upward tendency of the new trade in exporting Indian coal. This view receives confirmation when it is known that the increased production of the Indian mines has been on a higher ratio than necessitated by the enhanced demands of the railway *plus* the exports, so that we are warranted in concluding that the industries of India have made a substantial advance within the period in question.

Expansion.

Limits of Demand.

Exports.

Railways.

Imports.

Foreign Trade.—The record year in the imports was 1888–9, when (including Government Stores) India drew from foreign countries (mostly the United Kingdom) 877,843 tons of coal, coke and patent fuel, valued at Rs. 2,00,95,105. Five years later (1893–4) the imports were 591,007 tons, valued at Rs. 1,03,52,699; in 1898–9 they had decreased to 379,225 tons, valued at Rs. 73,60,786; in 1903–4 they were only 206,829 tons, valued at Rs. 38,66,882; and in 1906–7, 262,286 tons, valued at Rs. 49,47,445. Thus there can be little doubt the imports have given place to local production, and obviously so when in 1903, 7,438,386 tons of Indian coal were supplied for about the same sum as fetched only 877,843 tons of foreign coal in 1888.

Steady Decline.

Relative Price.

The following shows the Imports and Exports of Coal, Coke and

Patent Fuel during the years 1897–8 to 1906–7 (including Government stores) :—

Imports and Exports.

YEAR.	IMPORTS IN TONS.	EXPORTS IN TONS.
1897–8	276,407	213,146
1898–9	379,225	327,207
1899–1900	481,190	304,887
1900–1	142,467	542,023
1901–2	285,786	525,047
1902–3	228,562	431,801
1903–4	206,829	493,070
1904–5	275,205	594,251
1905–6	186,911	837,251
1906–7	262,286	940,054
AVERAGE	272,486	520,873

Coke to Coal.

In these returns each ton of coke has been counted as 1½ tons of coal.

Imports.

Receiving Province.

Exports, Receiving Countries.

It has been urged that the above figures are unimportant when contrasted with present production. That may be quite true, but only so long as it is recollected that the imports are now just one-fourth the quantity of those in 1888–9 and that the exports have now (1906–7) exceeded the transactions of the record year of imports. As illustrative of the normal direction of the foreign traffic, it may be explained that by far the major portion of the imports comes from the United Kingdom. The analysis of the total supply in 1906–7 would be as follows :—from United Kingdom 227,158 tons ; from Japan 4,505 tons ; from Australia 25,863 tons, and from all other countries the balance. The receiving province is Bombay, which in 1906–7 took 220,751 tons out of the total (262,286 tons). Of the exports, Ceylon and the Straits Settlements are the most important foreign receiving countries. Out of the total exports in 1906–7 Ceylon took 404,149 tons and the Straits 293,788 tons, and these figures approximately represent the relative demands of the countries named during the past five years. Practically the whole of the exports are made from the port of Calcutta, which being near the Bengal fields is the natural centre of distribution.

Possible Future Market.

To dream of a future of greatly expanded foreign export of coal from India does not necessarily involve the acceptance of a literal fulfilment of Horace Walpole's reputed prophecy that "England will be some day conquered by New England or Bengal." An export trade has become an established fact and one of great possibilities. His Excellency Lord Curzon, after inspecting a portion of the Jherria Coalfield, addressed a company of gentlemen interested in the coal-mining industry on January 22, 1903. Speaking of the foreign trade, his lordship said :—"Indian coal can hardly be expected to get beyond Suez on the west or Singapore on the east. At those points you come up against English coal on the one side and Japanese coal on the other. But I wish to point out that there is a pretty extensive market between, and I think that Indian coal should make a most determined effort to capture it."

Coastwise Trade.

Coasting Trade.—The foreign exports represent, however (on an average) but one-fourth the total exports by sea from Calcutta. The other port towns of India itself draw very largely on Bengal for coal. Bombay is by far the most important receiving port : in 1905, 1,067,779 tons were consigned to the western capital. Then comes Rangoon, which in 1905 took 361,572 tons of Bengal coal ; Karachi, 343,406 ; Madras, 199,425 ; Goa, 21,228 tons, etc. It is by seizing this interprovincial trade that the Bengal mines have so effectually curtailed the foreign imports.

Internal Trade.

Rail-borne Traffic.—But it must not be forgotten that the figures quoted are neither the total exports from the Bengal mines nor the total receipts of the towns in question. Large quantities are carried by rail and river, and of course from all the other mines besides those of Bengal. The figures reviewed are alone those of the traffic by sea. The total transactions by rail in 1906–7 came to 7,648,688 tons. The corresponding returns for 1899–1900 were 3,921,623 tons. Calcutta drained in 1906–7, 5,353,013 tons, all but 1,868 tons being from the Bengal mines. The United Provinces of Agra and Oudh in the same year received 688,507 tons, chiefly from Bengal. This represents the manufacturing enterprise of Cawnpore mainly. Bombay Presidency obtained Bengal or foreign coal from Bombay town, but over and above fairly large quantities from the Nizam's Dominions, the Central Provinces, Bengal and Rajputana. Madras Presidency procured its coal from the Nizam's Dominions and the Madras ports (and therefore very largely Bengal coal). Lastly Mysore State drew on the Madras ports, and consequently consumed Bengal coal chiefly. The bulk of these rail-borne transactions, it may be presumed, are concerned with the internal industries, since the railways derive their supplies direct from the mines, which are often owned and worked by the railway companies.

Bengal supplying. Cawnpore and Bombay.

Singareni supplying Madras.

Indian Production.

OUTPUT OF THE INDIAN MINES.—It may suffice the purposes of this abstract of information regarding the location, extent and prosperity of the Indian mines to furnish a collective statement of the production for all India :—

YEAR	ASSAM.	BALUCHISTAN.	BENGAL.	BURMA.	CENTRAL INDIA.	CENTRAL PROV.	HYDERABAD.	PANJÁB AND KASHMIR.	RAJPUTANA.	TOTAL.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1898	200,329	13,372	3,622,090	6,975	131,726	119,709	394,622	85,862	511	4,608,196
1899	225,623	15,822	4,035,265	8,105	164,569	156,576	401,216	81,835	4,249	5,093,260
1900	216,736	23,281	4,978,492	10,228	164,489	172,842	469,291	74,083	9,250	6,118,692
1901	254,100	21,656	5,487,585	12,466	161,362	191,516	421,218	67,730	12,094	6,635,727
1902	221,096	33,889	6,259,236	13,302	171,538	196,981	155,424	56,511	16,503	7,124,480
1903	239,328	46,909	6,361,212	9,306	193,277	159,154	362,733	11,703	21,764	7,138,386
1904	266,765	49,867	7,063,680	1,105	185,774	139,027	449,546	15,864	45,078	8,216,706
1905	277,065	41,725	7,231,103	—	157,701	147,265	454,294	62,622	42,964	8,417,739
1906	285,490	42,164	8,617,820	1,222	170,292	92,848	467,923	73,119	32,372	9,783,250

With a view to supply the names of the chief mines, to exhibit their classification both geologically and geographically and to demonstrate their output, the following further statement may be given :—

Classification of Mines.

Output of the Gondwana Coalfields for the Years 1901–6.

COALFIELD.	1901.	1902.	1903.	1904.	1905.	1906.
Bengal :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Daltonganj ..	3,881	19,352	33,557	50,517	71,294	87,768
Giridih ..	694,806	776,656	766,871	773,128	829,271	803,321
Jherria ..	1,946,763	2,420,786	2,493,729	2,889,504	3,070,588	4,076,591
Rajmahal ..	436	219	335	274	414	577
Raniganj ..	2,841,699	3,042,223	3,066,720	3,350,257	3,262,536	3,650,563
Central India :—						
Umaria and Johilla ..	164,362	171,538	193,277	185,774	157,701	170,292

THE INDIAN COAL INDUSTRY

Output of the Gondwana Coalfields for the Years 1901–6*—continued.*

COALFIELD.	1901.	1902.	1903.	1904.	1905.	1906.
Central Prov. :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Bellarpur ..	—	—	—	90	148	916
Pench Valley	—	—	88	—	1,104	32,102
Mohpani ..	43,046	43,645	31,443	26,618	22,998	27,503
Warora ..	148,470	153,336	127,623	112,319	123,015	32,327
Hyderabad :—						
Singareni ..	421,218	455,424	362,733	419,546	454,294	467,924
TOTAL OF GONDWANA BEDS ..	6,264,681	7,083,179	7,076,376	7,808,027	7,993,363	9.348,884

Output of the Cretaceous and Tertiary Coalfields for 1901–6.

COALFIELD.	1901.	1902.	1903.	1904.	1905.	1906.
Assam :—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Makum ..	254,100	220,640	239,328	266,265	276,577	285,402
Smaller Fields	—	456	—	500	488	88
Baluchistan :—						
Khost ..	18,431	25,982	36,444	38,574	34,140	32,500
Sor Range and Mach ..	6,225	7,907	10,465	11,293	7,585	9,664
Burma :—						
Shwebo ..	12,466	13,302	9,306	1,105	—	—
Upper Chindwin	—	—	—	—	—	1,222
Kashmir :—						
Ladda ..	—	1,138	999	270	—	—
Panjáb :—						
Dandot (Salt Range) ..	67,730	55,373	43,704	45,258	61,618	57,438
Attock ..	—	—	—	336	715	10
Shahpur ..	—	—	—	—	289	15,671
Rajputana :—						
Bikanir ..	12,094	16,503	21,764	45,078	42,964	32,372
TOTAL OF TERTIARY BEDS	371,046	341,301	362,010	408,679	424,376	434.367
GRAND TOTAL OF INDIAN COAL	6,635,727	7,424,480	7,438,386	8,216,706	8,417,739	9,783,251

Indian Gas-works.

Coal-gas: Coal-tar.—It is exceedingly difficult to obtain information regarding the gas-works of India. In the *Financial and Commercial Statistics* published by the Government of India for 1904 (more recent figures are not available), mention is made of two gas-works, one in Calcutta, the other in Bombay. These gave employment to 581 persons. It is believed there are other gas-works here and there all over the country, but mostly of a private nature, and therefore not returned under "Larger Industries." It is understood also that English coal is largely, if not exclusively, employed in gas-making, and the by-products of these works are doubtless disposed of but are not worked up to the extent customary in Europe. The coals most suited are coking coals that burn with a long flame.

By-products.

In the dry distillation of coal and in the manufacture of illuminating gas, volatile products are obtained that condense and separate into (*a*) a watery liquid and (*b*) a tarry mass. The former is one of the chief sources of ammonia and its salts (see **Alkalis**, p. 48), and the latter constitutes coal-tar. (For *Wood-Tar*, see **Pinus**, p. 890.) The average results with good coal are:—gas 16·6 per cent.; ammoniacal liquor 14·1 per cent.; tar 5·3 per cent., and coke 64 per. cent. From coal-tar may be prepared benzene (the commercial benzol), naphthalene, anthracene and phenol, also pitch. Briefly it may be said that benzene can be converted into aniline, naphthalene into indigotin (indigo), anthracene into alizarine, and phenol into carbolic acid. The reader will find numerous technical works that deal with these substances and their manufacture. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 55–87; Rawson, Gardner and Laycock, *Dict. Dyes, Mordants, etc.*, 1901, 93–110.]

Colours.

The coal-tar colours may be spoken of as discovered by Dr. (the late Sir) W. H. Perkin in 1856. He was then engaged in a study of the synthetic production of quinine, when he noticed that aniline on being oxidised gave a colouring matter. This he produced separately and gave to the trade under the name of "Mauve." This was the first of the long series of colours destined in a remarkably short time to revolutionise the tinctorial industries of the world—the Aniline and Alizarine Colours. The influence of these modern mineral dyes has been more destructive to the tinctorial and textile industries of India than is commonly supposed. They have depraved the artistic feelings of the people, and demoralised many of the indigenous crafts. But it doubtless can be upheld that the advances of modern tinctorial science have, in their ultimate issues, been in reality more constructive than destructive. The majority of the Indian vegetable dyes are fleeting, especially the yellows and greens. The best colours are the reds and blues. All Indian dyes are relatively expensive and troublesome, and one of the most imminent modern dangers lies in the fact that there are good and bad, cheap and dear, fast and fleeting qualities of the coal-tar dyes. It has been in fact computed that there are at present about 2,000 distinct colours of this kind offered for practical use, the manufacturers of which are often prepared to send expert dyers to the workshops of their customers in order to instruct the operatives in the technicalities of the dyes they sell. Recently it has moreover been proposed that a "key-board" of colours should be established, with fixed numbers for each shade, so that the buyers of Indian goods may be able to dictate the colours to be used. This may be desirable for certain commercial transactions, but with the art crafts it is likely to prove pernicious. All the famed natural dyes and tinctorial combinations of India have been already imitated and their vernacular names given to the fabricated coal-tar preparations (*e.g.* **Peori dye**, p. 765), so that nothing is left undone that could expedite the complete overthrow of the indigenous crafts. This statement is abundantly upheld by the returns of the imports. The Anilines and Alizarines received by India were in 1876–7 valued at Rs. 4,60,266; in 1886–7 they were Rs. 10,08,034; in 1896–7 Rs. 60,63,256; in 1903–4 Rs. 82,67,010; in 1905–6 a slight decrease, namely to Rs. 75,71,314; and in 1906–7, Rs. 74,92,704. In another article (under **Indigofera**, p. 683) mention will be found of the progress in synthetical production of indigo.

Demoralised Indigenous Crafts.

Expensive.

Indian Dyes imitated.

Expansion of Trade.

Coke.

Coal: Coke.—An inferior quality of coke is obtained as a by-product of the gas-works. It should not contain more than 10 per cent. ash; it is useful for burning cement and lime, or for domestic purposes. When coal is carbonised in ovens for the express purpose of producing coke, larger quantities are used than during gas-making. Coke is the main product, not the by-product. The coke is therefore superior because it has a higher calorific value. Caking coals are those best suited for

Two Kinds.

Caking Coals.

coking because they form a compact coherent coke, but mixtures of caking and non-caking coal can be successfully carbonised. [*Cf.* Blount and Bloxam, *l.c.* 83.]

Manufacture.

Two Qualities.

Impro Metho

Backwardness of India.

Loss of Nitrogen.

Sulphate of Ammonia.

For many years past the Raniganj, Jherria and Giridih mines have manufactured coke. Their output was in 1902 returned at 128,910 tons, of which Raniganj produced 86,000 tons. Coke-making is a most important industry, and one in which the future will doubtless record much progress. It means the profitable utilisation of coal waste, and the accompanying prosperity of the metallurgical industries. There are two qualities, "hard" and "soft." Ward (*Rec. Geol. Surv. Ind.*, 1904, xxxi., 92 *et seq.*) has recently published an interesting paper in which he urges the necessity of introducing improved methods of manufacture of coke with a view to recover the valuable by-products presently being wasted. Commenting upon this paper, Holland has explained that the backwardness of India in this matter proceeds from the limited demand for coke for metallurgical purposes. "At present about 300,000 tons only of Indian coal are converted annually into coke, though a demand will naturally increase with the development of metallurgical industries. Even as matters stand at present Mr. Ward has shown that there is good ground for assuming that the additional outlay necessary for closed ovens of the 'recovery' as well as the 'non-recovery' type would be repaid. Assuming that the coal used for coke-making in India contains on an average 0·75 per cent. of available nitrogen, the present system of manufacture in open ovens means an annual loss of 2,250 tons of nitrogen, sufficient that is for the manufacture of 10,613 tons of sulphate of ammonia, which at £13 a ton is worth £137,969 or more than 20½ lakhs of rupees." As showing the full value of this contention it may be mentioned that it has been ascertained that Java imported in 1901, 21,700 tons, and in 1902, 23,400 tons, of sulphate of ammonia to be used as a sugar fertiliser.

Recovery-ovens.

Sulphur.

Experiments recently made on a large scale in Germany and America have confirmed the conclusions referred to above with regard to the suitability of Bengal coal for the recovery of ammoniacal by-products, and arrangements are now well advanced for the erection of recovery-ovens on the Giridih, Raniganj and Jherria fields. With a view to improving the local market for the products, experiments are being conducted by the Agricultural Department to test the suitability of ammonium sulphate for Indian sugar-cane and other crops, whilst to meet the probable demand for sulphur the Geological Survey has organised prospecting operations on a large scale in connection with the copper sulphide deposits known to occur within easy distance of the coalfields in Bengal.

Literature of Coke.

But to conclude these remarks on coke, it may be observed that so much has been written on the subject that to give even the more useful references would occupy much space. The *Journal of the Society of Chemical Industry* teems with descriptions of methods, apparatus and processes in all countries. Similarly, innumerable passages occur in these journals on the distillation of coal; on gas-making; on the gaseous products of coal; on the relation of petroleum to the hydrocarbons of coal; on the influence of lime on coal; on the determination of the nitrogen in coal; on coal-tar; on ammonia, etc., etc., subjects intimately associated with the future of the Indian coal and coke supplies. [*Cf.* Weeks, *Man. of Coke*, 1892.]

Briquettes.

Coal: Patent Fuel and Briquettes.—In connection with the observations already made regarding Bikanir, Kashmir and other coals it has been explained that an industry has been organised in the production of briquettes from these inferior coals. This overcomes their excessive moisture and makes them useful fuels. In Europe and America briquettes are produced in many different ways and of widely different materials. It would be beyond the scope of this work to deal with all the forms of briquettes, but the subject receives interest in India through the possibility afforded of utilising coal waste and working up inferior coals.

Coal Waste.

Electric Power.

Other methods of utilising the waste coal and bituminous materials might be mentioned, such as the manufacture of what is known as "water gas," "mond gas" or "heating gas." [*Cf. Imp. Inst. Tech. Repts.*, 1903, 345–6.] The conversion of the accumulation of combustible waste material, near the Indian mines, into gas and finally into electric power might become of infinite value not only to the mines but to numerous possible future industries likely to be originated in their immediate vicinity such as chemical works, potteries, etc.

D.E.P., ii., 398–409.

Cochineal.

COCCUS CACTI, *Linn.*; Milburn, *Or. Comm.*, 1813, ii., 208; *Proc. Board Agri. Madras*, Nov. 18, 1895, COCCIDÆ. The Cochineal-insect, Scharlach-worm, *kirmdána*, *kirmaz*, *kiranda*, *kirm*, etc. A Scale Insect native of Central and South America, Mexico, Guatemala, etc., and distributed by cultivation to the West Indies, Teneriffe, the Canary Islands, Algeria, to some extent even to Spain and also to Java, India, etc.

Two Forms of the Insect.

Habitat.

There are said to be two forms or qualities of this insect, the *grana fina* and *grana sylvestris*. The former is generally spoken of as the cultivated and the latter as the wild cochineal. The cultivated insect is both larger and more valuable than the wild, but whether these are distinct species or only races of the same insect cannot even now be said to have been definitely settled. The *grana fina* is reported to be a native of Mexico, whilst the *grana sylvestris* comes from South America. As against all this confusion only two certain facts can be set, the first being that recent and properly authenticated attempts to cultivate the true *grana fina* in India have utterly failed; the second that on three occasions a ***Coccus*** (possibly *grana sylvestris*) has, so to speak, broken loose in India and utterly destroyed the ***Opuntia*** throughout large tracts of the country.

History.

Introduction into India.

Nepaulry.

Warren Hastings' House.

The Cochineal insect was discovered by the Spaniards in Mexico in 1518 and made known to Europe in 1523, but it was not until 1703 that Leeuwenhoeck exposed the error of regarding the insect as a seed (*grana*). It is just possible that the Portuguese may have attempted to introduce it into India in the 17th century, since in 1786 Dr. Anderson of Madras sent to Sir Joseph Banks specimens of a dye-yielding ***Coccus*** which may have been a form of cochineal; and this seems to have determined the East India Company to endeavour to introduce the true insect. Accordingly in 1795 Captain Neilson (Royle, *Prod. Res. Ind.*, 1840, 60) brought from Brazil some ***Opuntia*** leaves with the insects still adhering. This was apparently, however, the *grana sylvestris*. But, as already stated, there is no knowledge of the acclimatisation of the *grana fina* in India. I may express my indebtedness to Major D. G. Crawford, I.M.S., for having called my attention to a passage in Seton Karr's *Selections from the Calcutta Gazetteer* (ii., 602):—"Nov. 10th, 1796. Rishra advertises for sale 'that pleasant and well-known villa of Rissura, about 50 bighas of ground and 120 bighas of Nepaulry, fully planted and now ready to receive the insect.' The well-known villa may have been Warren Hastings' house at Rishra." It is not known whether a purchaser was ever found, but there is no doubt that about the time indicated, Indian public opinion was greatly concerned with the prospect of a satisfactory acclimatisation of the true cochineal. The chemical achievements of subsequent years completely obliterated, however, all interest in the dye, and Rishra is no more a popular resort but a jungle of Opuntia and other weeds. [*Cf.* F. Brandt, *Cult. of Silk*, résumé from *Rec. Madras Govt. and Board of Rev.*, 1871, 2 (Cochineal introduced by Dr. Anderson); also "*Nopalry*" (defined as "Garden for Cultivation of Cochineal Plant and Insect"), 13.]

Food of the Insect.

The favourite (and apparently the exclusive) food-plants of cochineal are various forms of ***Opuntia*** or ***Nopal***—the prickly pear (see **Opuntia**, p. 822). The *grana fina* feeds mostly on ***Opuntia coccinillifera***, *Haw.*, whilst the *grana sylvestris* is reported to live on several species, including ***O. monacantha***, *Haw.*, and the common Indian form ***O. Dillenii***, *Haw.* Considering the prevalence of the species of ***Opuntia***, it may be said there are not many recently collected specimens of the genus from India in the Royal Herbarium, Kew.

Herbarium Specimens.

Five species are, however, represented by the sets present, and these in alphabetical sequence are: ***O. decumana***, ***O. Dillenii***, ***O. ficus-indica***, ***O. monacantha*** and ***O. tuna***. There is no specimen of ***O. coccinillifera***. and—which may also be regarded as somewhat significant—there is only one sample of ***O. Dillenii*** from Madras, and that contributed in 1886, so that it would almost seem as if that plant had not been known, or at all events little experimented with in South India, much before the first decade of the 19th century. On the other hand, there are admirable samples from Madras of the other species just named, which are stated to have been collected from Dr. Anderson's garden on April 19, 1809. These are accordingly historic specimens. Of ***O. monacantha*** it is said that it was "the food of the wild cochineal." That same species has on two subsequent occasions been sent from Madras Presidency and once from the Panjáb, so that it is probably widely distributed in India, and completely acclimatised. Of ***O. ficus-indica*** another Madras historic sheet bears on the label the following observation: "It is not eaten by the wild cochineal." The specimen of ***O. decumana*** was wrongly named ***O. coccinillifera*** in the series from Dr. Anderson's garden, but there is no mention of whether or not the true cochineal insect fed on this or any other species grown in Madras. ***O. decumana*** has more recently, however, been sent from Madras, so that it appears to have become acclimatised. Lastly there is only one sheet of ***O. tuna***, and it also came from Dr. Anderson's garden in Madras. Most of the Indian specimens of ***Opuntia*** preserved in the Herbarium, Kew, bear a parasitic scale insect (possibly a species of ***Diaspis***), but no trace of cochineal. It thus seems possible the sudden extermination of the Opuntias of certain districts (such as that mentioned in Wilks, *Hist. Mysore*, iii., 89, in connection with Tippu Sultan) might be accomplished by the parasite mentioned, without supposing the sudden appearance and disappearance of a form of cochineal.

Red and Yellow Flowers.

The fact, however, that certain Indian writers affirm that the cochineal will only feed on red-flowered Opuntia while others say that it prefers the yellow-flowered plant, is perhaps best explained by the supposition that there are at least two races or species of cochineal in India, though as yet not separately recognised by entomologists. Dr. Bourne (*Rept.*, July 26, 1897) obtained *grana sylvestris* insects from Ganjam and found these on the yellow-flowered Opuntia; they lived for a short time, and only a little longer on the red. He accordingly inferred that as a measure of extermination of Opuntia the rearing of any form of cochineal was attended with so much difficulty that it was a failure. But it may thus be asked, would similar failure necessarily result with all the other species of Scale Insect seen on the Opuntias?

Life History of Insect.

The cochineal insect at its birth is viviparous and the male and female larvæ are not distinguishable even under the microscope. After a few days, however, they fasten to the cactus-leaf, lose the power of locomotion, and become covered—the *grana fina* by a short white down, and the *grana sylvestris* by a much longer cottony substance which conceals the insect. The creature destined to become the male is enveloped, along with the females, but in time becomes encased within a separate pouch or purse open at the blottom. From this in due time it emerges as a scarlet fly possessed of long transparent wings. It rarely flies, however, to any distance but jumps and flutters about while visiting the females, and shortly after dies. The female, on the other hand, never emerges from her case as a winged insect, in fact never moves again from the position she took as a larva, but becomes absolutely torpid, round in shape, loses her eyes and even all form of a head. She derives nourishment by means of a hollow pointed tube, which she plunges into the fleshy texture of the cactus. She begins to yield her offspring after about three months, and it is at this stage that the process of "nesting" is begun.

Propagation.

Some eight or ten females are picked off the cactus and put into a little bag of cotton-gauze or other cellular tissue, which is fastened to the underside of a fresh cactus-leaf by means of a thorn. The young larvæ escape, seek out good positions, and when fixed repeat their cycle of birth, growth and death.

Collection. **Grades.**

The female alone produces the dye, and is gathered for that purpose immediately before the birth of her young. It is said that if the insects are stove-dried, their natural white powdery covering is retained, and the more valuable "silver-grey cochineal" produced, but if killed by steam or hot water they lose their covering and "black cochineal" is the result. There is, however, an alternative opinion to the effect that quality depends on choosing the right period to gather the insects. There are three commercial grades, viz. "silver grain," "black grain," and the little valued "granilla."

Uses. **Ingrained.**

USES AND COMMERCIAL FORMS OF COCHINEAL.—Cochineal was formerly much employed in dyeing wool, silk, and cotton: to-day it is a colour-ingredient of drugs and confectionery, and an artists' pigment. It is almost entirely replaced by aniline dyes. Two different reds are obtainable from it—a bluish-red called crimson, and a fiery-red called scarlet. The great reputation these dyes enjoyed for many years gave to the English language the expression "ingrained."

Carminic Acid. **Carmine Red.** **Alum.** **Tin.**

Cochineal is comparatively rich in tinctorial matter compared with most of the other natural dyes; it contains from 10 to 20 per cent. of the pure substance which exists as a glucoside, "carminic acid," from which the true colouring matter, carmine red, is readily produced. The dye-stuff requires no preparation for the market, but before being employed by the dyer the insects are beaten to a powder. As already observed, the most valuable commercial form is "silver-grey" or "silver grain," the white film which is here retained being due to a natural wax *coccerin* amounting to about 1 or 2 per cent. of the weight of the substance. This silvery coating is sometimes imitated by facing the cochineal with talc and other mineral matter. In dyeing, cochineal is almost exclusively used for the production of scarlet shades on wool in conjunction with a mordant of tin. With alum mordant it yields a crimson shade. The Spanish historian Herrara tells us that alum was the mordant used by the Mexicans, and certainly, as far as Europe is concerned, it was not until 1643 that "Kuster or Kesler, a German chemist," brought to London the secret of using a tin solution in producing the true scarlet. This secret he communicated to a Flemish painter, who in turn told or sold it to the famous Gobelins, whose tapestries embraced practically the first instances of scarlet-dyed hangings.

Painters' Colours. **Red Ink.**

In connection with painters' colours, red inks, etc., the best-known modern application of cochineal is in combination with alumina and tin to produce Carmine (*D.E.P.*, ii., 167) which is an almost pure lake. The best quality is known commercially as *nacarat carmine* and is insoluble in water, alcohol, ether, turpentine, etc., but soluble in strong mineral acids. Other lakes prepared with cochineal are Florentine and Crimson-lake. None of the preparations retain their intensity of colour when long exposed to light. [*Cf.* Hurst, *Painters' Colours, etc.*, 1901, 261; Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 1901, 110; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 327.]

Trade. **Imports.**

TRADE.—As a dye, cochineal has been to a great extent superseded by aniline dyes, and this supersession appears to be steadily increasing. Thus the average quantity of cochineal imported by India annually during the five years 1894–5 to 1898–9 was 1,829 cwt. During the seven years 1899–1900 to 1905–6 the average was only 1,583 cwt. In 1903–4 the amount had fallen to 1,156 cwt., valued at Rs. 1,19,417, though in 1904–5 it rose to 1,380 cwt. (Rs. 2,22,914), and in 1906–7 to 1,533 cwt. (Rs. 2,62,568). In the same period of twelve years the imports of aniline dyes had increased by just over 100 per cent., totalling in 1906–7, 6,003,849 lb., valued at Rs. 46,55,054. Cochineal comes almost exclusively from the United Kingdom and France to Bombay. The re-export trade has practically vanished. [*Cf. Paulus Ægineta* (Adams Comment.), 1847, iii., 180; Honigberger, *Thirty-five Years in the East*, ii., 258; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 170; *Pharmacog. Ind.*, 1890, ii., 99; De Candolle, *Orig. Cult. Plants*, 274–6; *Kew Bull.*, 1892, 144–8; Mollison, *Rept. on Prickly Pear as Fodder*, 1892; Gennadius, *Opuntia in Cyprus*, 1897; Bourne, *Ind. Agri.*, 1898; Maiden, *Agri. Gaz. N.-S. Wales*, 1898, 9, 980–1008; Thorpe, *Dict. Appl. Chem.*, 1898, i., 575.]

D.E.P., ii., 415-59 **Cocoanut.**

COCOS NUCIFERA, *Linn.*; *Fl. Br. Ind.*, vi., 482; Fryer, *New Acc. E. Ind. and Pers.*, 1672–81, 7 and pl.; Miquel, *Fl. Ned. Ind.*, 1855, iii., 63–72; Shortt, *Monog, The Cocoanut Palm*, 1888; Nicholls, *Textbook Trop. Agri.*, 1892, 165 *et seq.*; Semler, *Trop. Agrik.*, i., 616–58; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 25–33; Mukerji, *Handbook Ind. Agri.*, 1901, 284–7; Cook, *Orig. and Dist. Cocoa Palm* (contrib. from *Nat. Herb. U.S.A.*), 1901, 257–93; Gamble, *Man. Ind. Timbs.*, 1902, 739; Safford, *Useful Pl. of Guam* (contrib. from U.S.A.), 1905, 233–43; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 198–200; PALMEAE. The Cocoanut (Coconut) Palm, Porcupine-wood, known in the chief Indian and Eastern vernaculars as *nárel, náriyal, nárikel, nárgil, maar, tenga, thenpinna, kobbari, nur, kalapa,* (Mal.), *pol* (Sinh.), *ong* (Burm.), *niu* (Poly.), etc., etc. This tall pinnate-leaved palm is indigenous to the islands of the Indian and Pacific Oceans, but now cultivated throughout the tropics in all warm moist situations, such as along the sea-coasts of India and Burma.

Habitat.

Fruit Production.

Proximity to the Sea.

Indian Area

Habitat.—The cocoanut is essentially a tropical plant, and while it can grow up to the 25th degree N. or S. latitudes, it but rarely ripens fruit in the extreme limits of its region. From the Bay of Bengal it follows the Gangetic basin inland some 200 miles, but on the coast of India generally does not penetrate for more than half that distance. Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 150) found that it ripened fruit with difficulty at Dinajpur, but I have seen it do so at Falakata, which is considerably farther to the north, and a writer (*Journ. Agri.-Hort. Soc. Ind.*, 1898) speaks of it fruiting freely at Dam Dim in Jalpaiguri, or 300 miles from the sea. It also fruits abundantly in South Sylhet. It would thus appear that the limit of fruit-production, viz. the 25th degree, is frequently exceeded in the immediate basins of large rivers. Hence it may even grow in Assam, though it will there ripen its fruits very indifferently. On the west and south coasts of India, on the other hand, its cultivated distribution is much more restricted. In Kolaba and elsewhere it may be found on the immediate shore and for 50 to 80 miles inland, ascending the hills to about 3,000 feet. Further to the South in Mysore, for example, it passes inland to nearly double that distance. It very possibly gave the name to the Cocos Islands and is plentiful on the Laccadive and Nicobar groups, but not in South Andaman. Gamble says "the cocoanut palm is not, like the palmyra, a forest tree, though it may be seen practically in forest, grown in gregarious plantations all round the Indian coasts and on some of the islands." The Indian region may thus be said to be the lower basins of the Ganges, Brahmaputra and Irrawaddy, also the Malabar and Coromandel Coasts and adjacent islands—Madras Presidency being the chief producing area.

History.

Distribution.

Insular Habitat.

Classic Names.

History.—On the assumption that it originated in the islands of the Indian and Pacific, there would be little to prevent its having been carried even by currents of the sea, or in some cases by primitive man, to the western shores of America and to the coasts of Southern China, Siam, Burma and India, in prehistoric times. This is so natural and obvious a supposition as to render most of the learned arguments indulged in by authors on this subject superfluous. The Spanish, Portuguese and Dutch travellers may have greatly aided in its distribution, more especially in conveying it to the east coast of America, to the West Indies and to Africa, but a wide natural distribution had doubtless taken place long anterior to the discovery of America. It is, therefore, hardly of serious consequence whether or not it may have been indigenous to tropical America as well as to certain of the islands of the Pacific. Its natural habitat is undoubtedly maritime. It is known by so many widely diversified names, in the regions of its present production, as to necessitate a vast antiquity. But as possibly indicative of a stronger claim for an Asiatic than an American origin, derivatives from its Sanskrit name *nári-kela* have accompanied the palm eastward very nearly to the shores of America and westward to Madagascar and Turkey, to a far greater extent than can be shown for any other classic or ancient name that it possesses. This does not of necessity involve its being accepted as indigenous to India, but simply that its extended cultivation accompanied Sanskrit influence.

De Candolle ultimately inclined to the idea of an origin in the Indian Archipelago. [*Cf. Orig. Cult. Plants*, 429–35.] Cook has taken great pains to refute De Candolle's arguments and thus to stoutly uphold an American origin. He maintains that it is no fault of the palm that the early inhabitants of America neglected to record its history, but similarly neither was that neglect India's "fault."

Actual Records.

We are justified in dealing with the records that exist. Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 419) advances no personal opinion but quotes authority for a dual nationality (American and Asiatic.) Jumelle (*Les Cult. Colon.*, 1901, 88–101) is opposed to the belief that the nuts were brought by currents from America to India and inclines rather to the view of an Indian origin. The plant was known to Cosmas in the 6th century A.D. (who calls it *argellion*, a name doubtless derived from the Sanskrit), and John of Monte Corvino, in the 13th century, speaks of it as the "Indian Nut" (as the Arabs do to this day). [*Cf.* Yule, *Cathay and The Way Thither* (ed. Hakl. Soc.), clxxvi., 213.]

Early European Knowledge.

It was also seen and mentioned by Marco Polo in the 13th century, under the name "Indian Nut." [*Cf. Travels* (ed. Yule), i., 102; ii., 236, 248, etc.] In later times exhaustive and most picturesque accounts of the cocoanut in India were given by Varthema (*Travels*, 1510 (ed. Hakl. Soc.), 163), by Linschoten (1598 (ed. Hakl. Soc.), ii., 43–51), by Baber (*Memoirs*, 1526, Leyden and Erskine, transl., 327), and by Abul Fazl (*Ain-i-Akbari*), etc., etc., to whose accounts the well-known description in *Household Words*, and later that of Tschirch (*Indische Heil-und Nutzpflanzen*, 1892, 144–56) appear to owe much.

Greek and Latin Knowledge.

The question of the early European knowledge of the cocoanut is discussed by Rumphius (*Herb. Amb.*, 1750, i., 8), who quotes the passages of Theophrastus (*Hist. Pl.*, iv., 2 (ed. Scaliger), 1644, 286) and of Pliny (*Hist. Nat.*, xiii., ch. 9 (Holland, transl.), 1601, 390) which have been supposed to refer to ***Cocos nucifera***. The names given by these ancient authors are *Cuciofera* and *Cocos*, but *cocos* might be given to any nut. A much more likely derivation is that furnished by Barros (1553), Garcia de Orta and Linschoten, viz. from the Spanish *coco* (*macaco*, Portuguese) applied to a monkey's face, an admirable allusion to the three scars or markings on the base of the shell. *Coca* (a shell) might have been the primitive suggestion of that name. [*Cf.* Oviedo, *Hist. Gen. Nat. de las Ind.*, 1526 (ed. 1851) i., 335; Garcia de Orta, 1563, *Coll.*, xvi.; Acosta, *Tract. de las Drogas*, 1578, 107; Pyrard, *Voy. E. Ind.*, 1601 (ed. Hakl. Soc.), ii., 372–86, etc.); Clusius, *Arom. Hist.*, 1605, i., ch. xxvi.; Boym, *Fl. Sin.*, 1656, f–f2; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 17; Hamilton, *New Acc. E. Ind.*, 1727, i., 296, 306; Forster, *Pl. Esc.*, 1786, 48; Sprengel, *Hist. Rei Herb.*, 1808, 103, 269; Milburn, *Or. Comm.*, 1813, i., 277–8; *Paulus Ægineta* (Adams Comment.), 1847, iii., 438–9; *Hobson-Jobson* (ed. Crooke), 1903, 228–9, 233–4; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 299, 360.]

Cultivation.

CULTIVATION.—For seed purposes ripe nuts should be chosen from trees of mature growth but not too old. After being kept from four to six weeks, seed-nuts are planted just below the surface of the soil and about a foot apart. Ashes and salt are freely scattered in the trenches as manure and as a protection against insects. The seedlings thus obtained may be planted out from two to six or more months later, preferably at the beginning of the rains. Such is the usual method, which will be found described fully in the *Dictionary*. In some parts of India, however, the young plants are not removed from the seed-beds for one or even two years.

Germination.

In Java and the South Sea Islands the Natives hang the nuts for some months in the open air, under the eaves of their houses, until the shoots and roots appear. The seedlings are then put into the positions which they are to occupy permanently. This method has been freely adopted by European planters owing to its great saving of labour and the ready facility it affords for rejecting bad or weak plants. A further method is to leave the nuts to dry for four to six weeks and then to lay them close together in a damp shady place until the shoots that appear from them are about 10 to 12 inches long.

Distance apart.

They are then planted in their permanent positions, and should not stand nearer each other than from 25 to 30 feet apart each way. It should be remembered that for fructification the cocoanut requires absolutely open air and plenty of sunshine. The subsequent treatment consists in hoeing the ground around the stems and manuring them, especially with salt, at the beginning of the rains. They may be easily transplanted when only a few years old, and in many cases with advantage, but the new pits into which they are placed must be filled with good soil, manure, and a little salt. [*Cf. Produce World*, Jan. 17, 1896.]

Salt as a Manure.

Yield.

Yield.—Cocoanut palms will bear fruit, according to the locality and the care expended on them, in from five to ten years. They throw out a spathe and a leaf every month, and each flowering spike yields from ten to twenty-five nuts. The yield varies according to the soil, climate, care expended, and also variety grown. It has been placed by some authors as high as 200 to 300, by others as low as 30 nuts per tree per annum, but a safe average might be 80 to 100, or say 5,000 nuts per acre; and at 4 lb. to each fruit this would give a total crop weight of 6½ tons an acre. Lastly, the palm will continue to bear such crops for 70 to 80 years.

Nuts to Acre.

Forms.

Cultivated Forms.—Although the Natives recognise many varieties or races, these are doubtfully distinct botanically. Moreover, they are so numerous that it would be almost impossible to enumerate even the better known "sports" and cultivated conditions that are claimed to exist. There are, for example, 25 commonly counted in Java—Miquel especially describes and names 18 of these and calls them varieties; 40 in the Philippines; 5 recognised in Ceylon; 30 in Travancore alone according to Dr. Shortt; lastly, Jumelle (*l.c.* 92) and Firminger, both compiling from M. Le Goux de Flaise, say of India that it is customary to recognise 7 forms:—(1) *Coromandel* or *Brahmin* nut, a yellowish-red form; (2) the *Kanara*, a very woody ovoid nut; (3) the *Malabar*; (4) *Maldive*, small and spherical; (5) *Achem*, small and ovoid; (6) *Nicobar* or pointed nut, the biggest of all, and (7) the *Ceylon* nut. The Brahmin nut is esteemed for its milk but is inferior in *kopra* and coir. Of Ceylon it is said there are two special dwarf forms: (*a*) the King Cocoanut, which produces a golden-coloured fruit but rarely attains a greater height than 20 feet. It is confined to the gardens of the better classes. (*b*) A still smaller plant much sought after.

Coromandel, Kanara, Malabar, Maldive, Achem, Nicobar, Ceylon.

Soil.

Soil and Climate.—All writers admit that the palm will grow effectively on sandy soil, but Semler and others point out quite clearly that it must not be dry sand. Many soils otherwise unsuitable can be adapted by adding the necessary manures; thus clay soils can be made porous by admixture of sand and fertilised by the addition of calcareous salts. Jumelle observes that the cocoanut requires heat, moisture, a porous soil, calcareous salts, alkaline salts, a certain quantity of sea-salt, and a fair amount of animal manure. It should be noted, however, that animal manure if too freely applied is apt to encourage a weevil pest (*vide infra*). The best manure (vegetable) appears to be cocoanut husks. [*Cf. Trop. Agri.*, 1893, xiii., 106-8.] Semler observes that the most desirable position is a porous soil sufficiently near the sea that at high tides the sea-water may permeate the trenches cut for that purpose. Cochran (*Trop. Agri.*, 1897, xvii., 173) and Jumelle (*l.c.* 94) give chemical analyses to show how very important salt is as a manure for this palm.

Manures.

Climate.

It is necessary that the temperature should be fairly even all the year round, 75° and 50° F. being the extremes. If the rainfall be evenly distributed throughout the year some 48 to 50 in. will suffice, but if less, the planter must resort to artificial irrigation. [*Cf.* Baur, *Ind. Gard.*, Dec. 14, 1899; Cochran, *Trop. Agri.*, 1900, xix.]

Bombay.

ADDITIONAL PECULIARITIES OF INDIAN CULTIVATION.—***Bombay.***—The cocoanut is only common in the south of this Presidency, and its chief value lies in the rich supply of toddy it affords. In Kolaba district, however, the soil and climate are found so suitable that the toddy exceeds the demand. The average annual yield of nuts is said to be about 120 per tree, and each palm may be reckoned to have cost about Rs. 9 up to the point at which it begins to yield. In Thana district the annual yield is estimated at 75 nuts to each palm. The dry nuts are sometimes thrown into a well and left to sprout there, being subsequently put into a nursery: or they are allowed to fall from the tree and then buried. In the Káthiawár district they are planted and grown in pits 3½ by 3 feet in diameter, cut out of solid limestone and filled with mould. In Kanara, Káthiawár and Ratnagiri the cocoanut is abundant, and in the latter district the average annual profit from each tree is said to be about Rs. 1-3-0. During the "*Narral Purnima*" or Cocoanut Festival of the Hindus, which is supposed to mark the end of the monsoon in August, Bombay Natives throw nuts into the sea to propitiate the god of storms. [*Cf. Madras Mail,* Aug. 23, 1899.]

Thana.

Káthiawár.

Cocoanut Festival.

Madras.

Madras.—This Presidency, especially the Malabar and Coromandel Coasts, is the chief seat of the Indian cocoanut industry. The Laccadive Islands also send their contingents to ports on the Malabar Coast, the produce of both being reckoned together. The Maldives are under a Sultan who is subordinate to the Governor of Ceylon; the coir produced is conveyed to India and lost sight of in the customary trade returns. The Godavari district has been called the "Paradise of the Cocoanut palm," the delta of the river showing an abundance of the trees. Mr. Lushington, District Forest Officer of Kistna, stated in the *Tropical Agriculturist* (Jan. 1, 1895, xiv., 457) that 200 nuts per annum was a very moderate estimate for good fruiting trees in the Godavari district, and indeed an even higher average (250 to 300 nuts per annum) has been quoted for Ceylon highly manured palms (*Trop. Agri.*, April 1, 1893, xii., 650). In Travancore 800,000 trees were counted during settlement operations in 1902, and it is estimated that 25 per cent. should be added for non-taxpaying areas. [*Cf. Capital,* Oct. 30, 1902.] In South Kanara, plantations extend along the whole coast-line, the average to the acre being about 120 trees each, yielding 40 to 50 nuts annually. The seed-nuts are usually not plucked but allowed to fall from the trees.

Laccadive and Maldive Islands.

Godavari.

Travancore.

S. Kanara.

Mysore.

In ***Mysore*** there are said to be four varieties of the cocoanut—red, red and green, light green and dark green. Toddy is not made from the palm, as the fruit is more valued. Occasionally a few green nuts are cut for the juice and for their fibre. The Mysore cultivation is to some extent peculiar, and a full account of it will be found in the *Dictionary.*

Nicobar.

On the ***Nicobar Islands*** the palm is very abundant, the annual yield being estimated at about 10,000,000 nuts. In the Andamans it is said to be a comparatively recent introducton. In 1901-2 there were estimated to be 42,997 cocoanut trees in bearing and 64,821 not, and in the same year 428,897 nuts were received into the oil-factory at Viper.

Burma.

In ***Burma*** success would appear to depend largely on the district. Mason (*Burma and Its People* (ed. Theobald), 1883, ii., 143) says that the palm will not thrive except near the sea, and in many parts the seedlings are believed to damp off. Some years ago it was reported there were 10,000 acres under cocoanuts in the Bassein district of Pegu alone.

Bengal.

In ***Bengal*** the cocoanut is plentiful throughout the lower Gangetic basin, but as a rule only in garden cultivation, and the produce is not much in excess of local demand. ***Phœnix*** and not ***Cocos*** is the palm used in this province as the source of toddy and sugar. In the districts of Barrisal, Backergange and Noakhali it is extensively grown in plantations by itself or along with the Areca-nut palm. Throughout Bengal the opinion prevails that to fruit well the lower two or three leaves must be removed in September.

Removal of Leaves.

In Upper India and the Central Provinces the cocoanut is not cultivated.

Enemies.

ENEMIES TO THE COCOANUT.—The greatest danger to which this palm is subject arises from the attacks of various insects, mostly the grubs of beetles. Of these ***Butocera rubus***, a large insect with a reddish-brown head, appears to attack the root and subsequently to find its way into the stem; it is believed to be especially prevalent when the ground has been too richly manured. Jumelle (*l.c.* 100) says a similar insect lays its eggs in the stem and the larvæ bore

Grubs of Beetles.

Eaten as a Delicacy.

Weevil.

their way to the terminal bud, which they devour. The danger of such pests is averted in the Straits Settlements by sprinkling the young palms with salt water. Another destructive beetle is ***Calandra palmarum***, a species of Elephant-beetle which destroys both the young leaves and the terminal bud, thus rapidly killing the palm. It is especially prevalent in the Malay States. On the Coromandel Coast boring grubs are extracted by means of a barbed steel probe. They are eaten as a delicacy by the Burmans, who are great adepts at extracting them. The Rhinoceros-beetle (***Oryctes rhinoceros***, *Linn.*), a large black or brown scarab, has been reported as especially destructive to palm trees in Madras and Singapore. It damages the trees by cutting holes through the young leaf-shoots. The larvæ of a large weevil (***Rhynchophorus ferrugineus***, *Oliv.*) kill a great number of trees by tunnelling into the trunks. The only cure for this is extraction, though the use of salt and brine is often beneficial.

Scale Insects.

The leaves of the palm are also much injured by other insect pests and the life-sap sucked from the plant. Certain of the *COCCIDÆ*—the Scale Blights—such as ***Aspidiotus destructor***, *Signoret*, and ***Dactylopius cocotis***, *Maskell*, are especially destructive in the Laccadive Islands, and are the more dangerous because it is difficult to proceed against them by ordinary methods of spraying. [*Cf.* Maskell, in *Ind. Mus. Notes*, 1896, iii., 1, 66–7.] Semler says (*l.c.* 645) that a large wasp is in the habit of making its nest in the young fruit. The only remedy is the destruction of the nest.

Larger Enemies.

Infected Timber.

Larger and more easily checked enemies are rats, squirrels, flying-foxes, wild cats, tree-dogs (***Paradoxurus***), etc., which sometimes eat the young fruits and often destroy the terminal bud. As a remedy, Semler suggests that a preparation of cocoanut kernel with arsenic, pulverised glass and strychnine, or the like, should be put into cocoanut shells and hung in the trees. Against rats the mongoose is the best protection. Nicholls recommends covering the trunk of the palm with sheets of tin or galvanised iron for some twelve inches, the rats being unable to climb over these. The young plants must also be protected against the ravages of wild hogs, elephants, cows and porcupines. When a palm has actually been killed by beetles or other pests, care should be taken to destroy the whole stem by fire, as a single palm left lying or utilised for posts, rails, handrails to foot-bridges, etc., may contain and send out enough of the pests to destroy an entire plantation. It has accordingly been suggested that the preservation by planters of infected timber as well as the non-destruction of infected cocoanut-refuse should be made a statutory offence, since such nearly always constitutes a public nuisance and too often involves a public disaster. [*Cf.* Ridley, *Rept. on Destruction of Cocoanuts by Beetles, Singapore*, 1889; Tennet, *Ceylon*, ii., 529; *Ind. Mus. Notes*, 1891, ii., 8–9; 1893, 175; 1903, v., 127; Watt, *Plague in Betel-nuts*, *Agri. Ledg.*, 1901, No. 8, 140; *Trop. Agri.*, 1904, xxiii., 636; Butler, *Diseases of Cocoanut*, in *Board Rev. Madras*, 1908, No. 786.]

Various Fibres.

FIBRE. This useful plant yields various fibres or fibrous materials. A delicate tomentum or cotton, found at the base of the leaf, is employed as a styptic. The leaves may be used like those of other palms for many of the purposes of paper. The leaflets of two or more leaves are braided into mats that are used in house-construction. They are also often stripped off and made into brooms, or their midribs separated and so used. Again, the leaves are frequently employed as thatch, and dried they may be utilised as crude torches. The half-fruit (nut with adhering pericarp) is largely used as a scrubber.

Coir.

History.—The important fibre, however, is of course the COIR which is obtained from the thick outer wall of the fruit (or husk). This seems to have been known to the early Arab writers as *kanbár*, being so called, for example, by Albirúní (*cf. Journ. As.*, ser. iv., tom. viii., 266) in the 11th and by Ibn Batuta (*Voyages, etc.*, *Soc. Asiatique*, 1858, iv., 121) in the 14th centuries. Correa (*Lendas da India*, ii., 129–30) tells us that the Governor (Alboquerque) of Cananor devoted much care (1510 A.D.) to the preparation of cables and rigging of coir (*cairo*), of which there was great abundance. Pyrard (*Voy. E. Ind.* (ed. Hakl. Soc.), 1887, i., 250) speaks of the revenue having been paid (in 1610 A.D.) of *cairo* by the Maldives. The word coir did not come into the English language until the eighteenth century. It is doubtless an Anglicised version through Portuguese *cairo* of the Malayal verb *káyáru* = to be twisted (*káyar*, Mal. and *káyiru*, Tam.). Both the fibre and the rope made from it appear to have been exported to Europe in the middle of the 16th century under the name *kánbar*, a misrendering, very possibly, of *káiyar*. But it was actually not until the Great Exhibition of 1851 that coir rope and matting attained commercial importance in England. Thus Milburn, writing as late as 1813, observes that cocoanuts are an article of considerable trade in all parts of India, and that coir ropes are much esteemed there. He says nothing at all of any exports to Europe. It deserves notice, too, that the collections of early letters of the East India Co.'s servants, published by Mr. W. Foster, contain no reference to the cocoanut fibre.

First Exported to England.

Production.—Taking India as a whole, coir is only obtained as a by-product. As will be seen under the notes on trade, the present-day Indian exports are almost entirely made from Bombay and Madras, and it may be said that Madras, Cochin, the Laccadives and Malabar are the only parts of India that produce coir on a commercial scale. According to the *Manual of S. Kanara* (1895, ii., 147–8) about 5,000 persons depend for their living on the manufacture and sale of coir in that district. It is further said that 3,000 cocoanuts produce 1 candy of coir. The cost of raw material and manufacture is about Rs. 15 and the selling price about Rs. 20 per candy. Elsewhere in India the fibre is dark and coarse, and not comparable to the fine qualities of the above-named districts or to that of Ceylon or Singapore. There are many reasons for this. Situation is one ; the fibre would seem to become coarser at a distance from the coast ; but variety, age at which the nut is gathered, care and skill in steeping, beating, and cleaning the fibre, etc., etc., are all factors of no small importance. If the palm be cultivated for the supply of juice or to afford ripe fruit, the fibre usually proves in the one case imperfectly formed and in the other overripe. Such, at least, is the common opinion, although according to Wiesner (*l.c.* ii., 420) only three varieties of ***C. nucifera*** are really suitable for the production of coir, viz. ***rutila, cupuliformis,*** and ***stupposa,*** and the first named gives the finest and most elastic fibre. These are three out of the eighteen forms given by Miquel. Wiesner, however, would appear to have adopted for general application a criticism which Miquel (*l.c.* 65) originally intended exclusively for the Dutch East Indies. In many countries such as Guam a specially long fruit is grown for the express purpose of affording the long straight-bristle fibre. Of Indian coir it has been commonly affirmed that the best comes from Cochin, and that as a result attempts have been made to imitate the light colour of the Cochin fibre by bleaching. But the chemicals used in this process destroy the elasticity of the fibre and render good qualities bad and inferior qualities worthless. Neither does it seem quite clear whether by Cochin coir is meant commercially the produce of the Native State or that of the whole coast of Malabar, or indeed all high qualities from whatever country obtained. It is said that for fibre the nuts should be cut in the tenth month ; it would appear, however that a large quantity of ripe nuts are exported to Europe in husk and the coir separated on arrival.

Coir a By-product.

Kanara.

Cost.

Coarse Fibre.

Specific Variation.

Specially Long Fibre.

Cochin.

Bleaching.

Manipulation.—Concise accounts of the various local methods of removing the fibre from the shell and of separating and cleaning the coir have been given in the *Dictionary* (*l.c.* 428–30), to which the reader is referred.

Preparation of Fibre.

Shelling.

Husk. Retting. Cleaned. Mat Quality. Broom. Prices.

Briefly it may be said that for the first process an iron spike is fixed in the ground with point upwards, and that the nut is so struck on this that the point penetrates between the nut and the husk, and causes them to separate. A Native can treat in this way about 1,000 nuts daily. Although many machines have been tried for this purpose, hitherto none have been found which can compete with hand-labour. The husks after being retted in brackish or sweet water for 7 to 18 months are crushed either by hand or by machinery, and the fibre extracted. Fresh water is said to injure the fibre. The retting process is sometimes dispensed with, the husk being steamed till the fibre separates. After being dried the fibre is "willowed" or cleaned of dust and refuse, and it is finally separated into various grades or qualities such as "mat" or long fibres (used for spinning purposes); "brush and broom 'bristle'"—the shorter and stiffer fibres; upholstery, the tow or curled fibre; and the dust or refuse employed as a manure and for other purposes. The best bristle fibre done up in small bundles, and with the fibre stretched straight and clean, may fetch £30 a ton. The mat fibre is worth £20 per ton and the waste £10 a ton.

Lining of Warships. Rope and String.

Under a high pressure a cocoanut dust was found to make a rather brittle cardboard which on being touched by water would instantly swell up and close any hole made in it. This was looked upon, some ten years ago, as a valuable discovery for rendering warships practically unsinkable by gun-fire. The ordinary uses of coir, coir-yarn, etc., are so well known in most households, that it seems superfluous to attempt an enumeration. Coir-matting, coir-ropes, cocoanut brooms and besoms, hassocks, hammocks, "bass" for nursery men, bags for seed-crushers, oil-presses, etc., are amongst the many forms of manufactured coir. Coir rope is especially serviceable in India because it does not suffer from the damp climate, and sails are accordingly sometimes made of coarse coir-cloth. In the Laccadive Islands mats made of cocoanut leaves are used as sails. In Ceylon and India the fronds are split and woven into neat baskets. [*Cf.* Dodge, *Useful Fibre Plants of the World*, 120–3.]

Yield.

Yield.—As regards yield of fibre per nut and price, it has been said that 10,000 husks treated in England yield about 50 cwt. of spinning fibre and 10 cwt. of brush fibre. In Ceylon 40 nuts are reported to give 6 lb. of coir (or say 13¼ cwt. to 10,000); in Madras 18 large nuts and in the Laccadives 60 small nuts give a similar amount; but whereas a pound of Laccadive coir spins to 35 fathoms (210 feet), a pound of the coir from large Madras nuts will only measure 22 fathoms (132 feet).

London Market.

Prices.—The quotations for Coir on the London market, as published by Messrs. Ide & Christie, October 15, 1907, may be here given. The spot values were as follows:—

	£	s.	d.		£	s.	d.
COIR YARN—							
Common to good Cochin Roping Dholls ..	11	0	0	to	14	0	0
,, ,, ,, ,, ,, Bales ..	12	0	0	,,	15	10	0
,, ,, fair Cochin Weaving ,, ..	14	0	0	,,	19	0	0
Fair to good ,, ,, ,, ..	20	0	0	,,	25	0	0
Good to extra ,, ,, ,, ..	25	0	0	,,	29	0	0
Common to fair Ceylon Dholls and Ballots ..	14	0	0	,,	18	0	0
Fair to good Ceylon Ballots and Bales	20	0	0	,,	22	0	0
Good to extra Ceylon Ballots ..	23	0	0	,,	28	0	0
COIR FIBRE—COCHIN, common	8	0	0	,,	15	0	0
fair	17	0	0	,,	19	0	0
good	20	0	0	,,	23	0	0
CEYLON, short to fair ..	6	15	0	,,	8	0	0
clean long	9	0	0	,,	11	0	0

	£	s.	d.		£	s.	d.
COIR ROPE—4½ to 6 inch ..	15	0	0	to	21	0	0
2½ „ 3½ „ ..	15	0	0	„	21	0	0
1½ „ „ ..	15	0	0	„	21	0	0

For the Month of September.

	Landed 1907.	Delivered 1907.	Stock Oct. 2. 1907.	1906.	1905.
YARN	190 tons.	485 tons.	1,600 tons.	2,925 tons.	1,936 tons.
FIBRE ..	90 „	106 „	234 „	521 „	794 „
ROPE	— „	13 „	164 „	216 „	88 „

	Landed from Jan. 1 to Oct. 2. 1907.	1906.	Delivered from Jan. 1 to Oct. 2. 1907.	1906.
YARN	3,791 tons.	4,861 tons.	4,723 tons.	5,012 tons.
FIBRE ..	786 „	1,144 „	629 „	1,423 „
ROPE	112 „	263 „	143 „	156 „

[*Cf. Text. Journ.*, Sept. 1892; Morris, *Cant. Lect.* in *Journ. Soc. Arts*, 1895, 932–3; Dodge, *Useful Fibre Plants of the World*, 1897, 120–3; *Kew Bull.*, 1898, (add. ser., ii.), 245–8; Hannan, *Text. Fibres of Comm.*, 1902, 151–4; Dunstan *Imp. Inst. Tech. Repts.*, 1903, i., 79.] [For Trade, see Collective Statement in Cocoanut Products, pp. 362–3.]

Copra.

COPRA (KOPRA) AND OIL.—The kernel of the cocoanut sliced and dried either in the sun or artificially is called *Copra* (*Kopra*). It contains from 30 to 50, some say even up to 70 per cent. of fixed oil. The fully ripe cocoanuts only are used in making *copra*, but though the quantity is less the quality is said to be higher in three-quarters ripe than in fully ripe fruits. But the oil may be expressed either from the fresh kernel or from the dried kernel, and by a hot wet or dry cold process. Artificially dried *copra* is often smoked, and as this colours the oil its value is thereby lowered. Mr. Cochran (*Man. Chem. Anal.*; also *Trop. Agri.*, May 1, 1893, xii., 665; July 1, 1899, xix., 44) gives the composition of *copra* thus:—moisture 6 per cent.; oil 67 per cent.; albuminoids 6·69 per cent.; carbohydrates 15·21 per cent.; woody fibre 2·11 per cent.; and ash 2·99 per cent. Semler (*l.c.* 653) observes that sun-dried *copra* contains about 50 per cent. of oil, artificially dried 60 per cent., and if dried at the boiling point of water it may contain 66 per cent.

Methods of Preparation.

Composition.

Chemical Property.

Oil.

Oil.—Dunstan (*Edible Oils, l.c.* 129) gives his examination of Malabar, Bengal and Bombay samples. The Malabar had an acid value as KOH of 35·21 as compared with Bengal 11·84, and Bombay 9·95; the saponification value of Malabar was 258·2, Bengal being 255·6, and Bombay 255·5; the iodine value of Malabar was 8·54, of Bengal 8·41, and of Bombay 8·25; the Reichert-meissel value of all three was found to be higher than the ordinary standard, viz. Malabar 6·71, Bengal 6·79, and Bombay 6·65; lastly the melting-points were Malabar 23·5° C., Bengal 24·5° C., and Bombay 25·0° C. Blount and Bloxam (*Chem. for Engin. and Manuf.*, 1900, 236) give the saponification of this oil as 209 to 228 and iodine absorption as 7 to 9. [*Cf.* Greshoff, *Rept. Kolon. Mus. Haarlem*, 1903; Bachofen, *Complete Anal. of Cocoanut, showing its demands on the Soil*, in *Times of Ceylon*, Nov. 1899.]

Trade Qualities

Extraction.

Extraction.—Various methods of obtaining the oil are resorted to: for example, when pure colourless oil is required the *copra* is boiled with water, grated and squeezed, the resulting emulsion being again boiled till the oil rises to the surface. This is thus a hot wet process. If fresh kernels are used this is called *ável* oil, and if from *copra* it is *muthel*. Moreover there are several special modifications chiefly intended to produce the very

Boiling.

Crushing.

Poonac.

pure white oil which has the highest commercial value. Crude or ordinary cocoanut oil is, on the other hand, produced by crushing the *copra* in a native oil-mill worked by oxen. This is a cold dry process, but some of the most highly prized grades have been cold drawn. The mill is really little more than an enlargement of the druggist's pestle and mortar, but it is so efficacious that the extra amount of oil obtained by employing European machinery does not counterbalance the expenditure involved. Moreover, the residue of the *copra* is sold as cocoanut oilcake (*poonac*), and the drier the cake the lower its value; the *poonac* is normally worth 25 per cent. of the *copra*.

Cochin Oil.

Improvement of Ceylon.

Smoke-dried.

Superior Quality of Nut.

Cold Dry and Hot Wet.

Price.

The best East Indian cocoanut oil is known as "Cochin." This is remarkable, since it is generally thought that ripe cocoanuts are necessary for the oil, whilst green nuts are best for the fibre. Yet "Cochin fibre" and "Cochin oil" both rank highest and possibly from the same reason, viz. that the name Cochin is given to all high grades. However, it is possible, as mentioned above, that what is called "Cochin coir" comes in reality very largely from the Laccadives and the Cochin oil may come from Cochin. In 1897–8 the *Tropical Agriculturist* opened its columns to a discussion as to the reason for the higher price obtained by Cochin compared with Ceylon cocoanut oil. The difference was then said to be about 36 per cent. But in January 1904 there was apparently little difference, and in May 1905 Cochin oil was selling at only 16 per cent. better than Ceylon; hence it may be assumed Ceylon had improved materially. During the discussion indicated an "Old Cocoanut Planter" observed that perfectly clean and dry *copra* yields an oil which if put in a tumbler is indistinguishable to the eye from a similar glass of water. The inquiry, it may be said in conclusion, resulted in a general agreement on several points, such as that the purity of colour and therefore higher price of Cochin oil were due to the greater care taken in the selection of nuts for crushing and in the preparation of the *copra*. It was acknowledged that smoke-dried *copra* usually resulted in a tainted oil; that none but quite ripe and quite sound nuts should be used (it was said, for example, that on the Cochin coast the nuts are allowed to drop off the trees); that great care should be taken to keep the split nuts free from dust and dirt whilst drying; and finally, that the excess of stearine in Cochin oil, which makes it preferable for candle-making, is due rather to the superior quality of the nut and more careful cultivation than to any natural superiority of the soil. Almost all Ceylon (European) growers, it may be observed, are agreed that one of the principal advantages of the Cochin climate lies in the fact that the *copra* can be dried in the sun. In the controversy above indicated it was stated, however, that if the *copra* were dried at an even temperature, where smoke could not reach it, the result would be equally good with the sun-dried nut. But it may be added the difference between cold dry and hot wet expressed oil may be a far more important factor than hitherto recognised in determining the value of cocoanut oil. All the cocoanut products seem subject to extreme fluctuations in price. It is generally accepted that the safest standard to purchase *copra* or cocoanuts is the price ruling for the oil.

Uses of the Oil.

The Oil is largely used in India both in cooking and for toilet purposes. Its employment as an illuminant was at one time important but has considerably diminished owing to the introduction of cheap American kerosene, the best qualities of which are cheaper than ordinary cocoanut oil. It is still, however, occasionally found in some Roman Catholic churches, and in England and elsewhere it is made into candles, especially nightlights. The latter use was a discovery made by Messrs. Price & Co., who introduced candles made with cocoanut oil for public illumination at the time of Queen Victoria's wedding; but in ordinary candle-manufacture the oil has been somewhat displaced of late by palm-oil. [*Cf. Board of Trade Journ.*, Feb. 1898.] In Europe it is extensively employed, particularly in France, where pomades and other fancy toilet articles are produced in great quantity and variety. It is also utilised in the manufacture of salves and lotions of various kinds and to adulterate cod-liver oil. It is considered an effective hair-restorer and is universally so used all over India. The long, black, lustrous tresses of the Filipino women have been attributed to the use of this oil. [*Cf. Hides and Leather*, June 25, 1904.]

Candles.

Pomade.

Hair-oil.

As regards the soap industry, cocoanut oil makes a white, hard soap, which is more readily soluble than almost any other in hard or even salt-water. The form known as "Marine Soap" may be used medicinally in plaster-making and in the preparation of soap liniment, but it has the disadvantage of imparting an unpleasant odour to garments or to the human skin. The Messrs. Lever's Sunlight Soap factories use a large amount of cocoanut oil. A fair proportion of the Native-made soap of India is also prepared by boiling this oil with dhobie's earth, salt, saltpetre, quicklime and water.

Soap.

"Marine Soap."

Vegetable Butter.—The various methods and contrivances for producing vegetable butter—cocoanut butter more especially—may be said to have originated one of the many new aspects of value in this palm. Pure cocoanut oil has for some time been used in part manufacture of margarine, and with advantage, since it supplies a certain amount of glyceryl salts, of fairly low fatty acids, whose absence from ordinary margarine constitute chemically the principal difference between that product and butter. For this purpose the characteristic odour of the oil is removed by treatment with alcohol and animal charcoal. [*Cf.* Blount and Bloxam, *l.c.* 238.] But a far more important industry than the adulteration or fabrication of margarine is the production of cocoanut butter (see **Cacao Butter,** p. 1076). The process of producing cocoanut butter or, as it was subsequently termed, "*palmin*," is said to have been discovered by a German professor, Dr. Schlinck, and developed by him at Ludwigshafen. He produced a pure vegetable fat which for culinary and edible purposes was claimed to be much superior to butter, lard or tallow, all of which contain acids that through heat form undesirable products. [*Cf. Ind. Agri.*, Sept. 17, 1887; *Kew Bull.*, 1890. 230–8; Basu, in *Journ. Agri.-Hort. Soc. Ind.* (*Proc.*), 1890, ix., 62–3.] Dr. Therner, Second Physician of the Imperial Hospital, Vienna, pointed out (*Centralblatt für die gesammte Terapie*, Oct. 1889) that a firm at Mannheim had also produced a cocoanut butter free of fatty acids, such as was suited for persons of impaired digestion. [*Cf. Journ. Board Trade*, June 1901.] The manufacture of these and such like butters was naturally very quickly extended, and indeed Messrs. Loder & Nucoline, Ltd., of Silvertown, London, claim to have preceded even the German firms in producing cocoanut butter and cocoanut suet, which they called "Nucoline" and "Vejsu." Their sales are now on a very large scale, so that their goods are coming daily into extended demand. "Vegetaline" is the name of the product as now manufactured in Marseilles. More recently Messrs. Gaudart

Butter.

Margarine.

Cocoanut Butter: "Palmin."

Free from Fatty Acids.

"Nucoline."

"Vegetaline."

"Cocotine."

& Co. have commenced making what they call "Cocotine" at Pondicherry. Similar factories have also been established in America and elsewhere. [*Cf. Madras Mail*, Jan. 23, 1902; *Ind. Agri.*, Nov. 1902, xxvii., 348; etc., etc.]

Future Prospects.

Superiority for Baking.

Independent Position.

There is thus an opening for Indian industries in this product which that country will be ill advised to neglect. The importance to Europe of the discoveries briefly indicated lies in the fact that cocoanut butter provides bakers and biscuit manufacturers with a substitute for butter which is not only pure and cheap but even better suited for baking purposes than butter proper. One of its chief advantages is that it does not readily become rancid, and recently the use of this butter has been authorised for culinary purposes in the French army, a fact significant of the future demands of the world. The consumption of this product must in fact yearly expand and the traffic become of infinite value. Confectioners are said to find cocoanut butter an entirely satisfactory substitute for the more expensive cacao butter (see p. 1076), the imports of which into England have in consequence for some years past materially declined. Cocoanut butter is not, however, strictly speaking, a substitute or even an adulterant of dairy butter, but a substance that commands independent recognition. [*Cf.* White and Humphrey, *Pharmacop.*, 1901, 331; *Revue des Cult. Colon.*, June 1903, No. 126, 324.]

Adulteration of Volatile Oils.

Adulteration. It should be added that cocoanut oil is sometimes used as an adulterant of volatile oils. It may be detected by the fact that oils so adulterated will solidify wholly or in part in a freezing mixture. Cocoanut oil has thus been found in *cananga*, citronella and palmarosa oils. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 201.] Cocoanut oil melts at 68° to 82° F.; its sp. gr. at 212° F. is 0·868 to 0·874 and its saponification from 209 to 228.

Poonac.

Fattening Property.

Cocoanut Oilcake or Poonac.—As observed above, this is the by-product of *copra*, after the expression of the oil. Voelcker (*Essay on the Influence of Chem. Disc. on Agri. reviewed in Trop. Agrist.*, 1896, xv., 800) is said to have observed that the cocoanut cake is better adapted for fattening stock than for young growing animals or store-stock. Its analysis is as follows:—water 9·50; oil 8·43; albuminous bodies 30·40 (containing nitrogen 4·50); mucilage, sugar, fibre, etc., 40·95; mineral matter (ash) 10·72. It was very largely taken up in Australia, after the establishment of Messrs. Lever Brothers' Sydney Oilmills. In the *Tropical Agriculturist* (1898, xviii., 223) it is stated that cocoanut oilcake is not generally used for milch-cows or other milking stock, or in Ceylon for horses; but it is the common food of working bulls, and is considered an excellent fattener for pigs.

Price.

Total Traffic

Madras.

Official statistics of the Indian trade in cocoanut cake are not available, but according to a reply to a correspondent in *Capital*, Feb. 11, 1904, the price in Ceylon was from Rs. 67½ to Rs. 70 per ton, and from 12,000 to 15,000 tons were then shipped annually from Colombo, mostly to Germany and Belgium. The writer apparently did not consider it necessary to take India into consideration. In fact he says Indian *poonac* consists of rape-seed, castor-seed and gingelly (sesamum). Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 403–6) gives the appearance of the cake under the microscope. The total exports of Indian oilcake, it may be observed, amounted in 1903–4 to about 60,000 tons, of which Madras contributed 47,500 tons. The exports of oilcake appear, however, under two headings (*a*) Cattle Food and (*b*) Manure.

The total for 1906–7 came to 105,379 tons, valued at Rs. 75,99,121. Cocoanut oilcake is chiefly exported from Madras, and consequently constitutes an important item in these transactions. The value of the total traffic and its present prosperity may be inferred from the fact that from all India the exports in 1886–7 stood at only Rs. 1,71,107. This is, however, but indirect evidence of the extent of the Indian exports in cocoanut cake. [*Cf. Kew Bull.*, 1897, 416; Leather, *Agri. Ledg.*, 1897, No. 8, 159–60.]

Medicine.

Avel and Muthel.

The Milk.

Toddy.

Medicine.—Very full accounts of the medicinal properties of the cocoanut are given in the *Dictionary* and in the *Pharmacographia Indica* (iii., 511–9). Briefly it may be said that, for European medicine, the most important advantages of *C. nucifera* are the anthelmintic action of the fresh fruit (especially of the volatile oil of the shell); the properties of the milk; as also the possibility of substituting the oil for cod-liver oil, in cases where the latter cannot be taken. For medicinal purposes the olein is separated from the solid fats, as in the preparation of what the Natives call *ável.* (According to some writers this is named *muthel*, the meanings of *ável* and *muthel* being perhaps reversed.) In making that substance the kernel of the fresh nut is pulped and strained and the oil separated from the milky fluid by heating. A preparation of the same kind is now known in Europe as "coco-olein." Both by Native and European physicians in India the "milk" from the unripe fruit is recommended as a useful refrigerant in fever and urinary disorders, but in Bengal it is commonly believed that the consumption of too much cocoanut milk tends to cause hydrocele. In dyspepsia and consumption Native practitioners prescribe the pulp of the ripe fruit made up with *ghi*, coriander, cumin, cardamoms, etc. This mixture is called *nárikela-khanda.* The flowers and fresh toddy are astringent. The soft, brown tomentum or cotton found outside the base of the leaf-sheath is an excellent styptic, like the corresponding products of *Borassus* and *Caryota.* For an abstract of the somewhat diverse and conflicting opinions of the Arab physicians—Rhases, Avicenna, Serapion, etc.—the reader should consult Adams (Comment. in *Paulus Ægineta*, 1847, iii., 438).

Edible Products.

Copra.

Juice.

Sugar.

Spirits.

Bombay Industry.

Cement.

Food Products.—With a large section of the Indian population the cocoanut is almost a staple article of diet, and a very wholesome one. Natives of all classes consume the soft creamy pulp and cool refreshing water (milk) of the young nut (*dáb*), and also use the same in cooking curry. The terminal bud or "cabbage," though esteemed a delicacy, is not often eaten, because its removal kills the palm. The harder pulp of the matured nut is dried either naturally or artificially and the *copra* thus formed is parched with rice, rasped, and put into curries or made into sweetmeats. The fresh or fermented juice of the stem is consumed as a beverage—toddy (*tari*); by evaporation it is made into *jaggery* (coarse sugar), and by subsequent treatment even refined sugar. Rheede (*Hort. Mal.*, 1686, i., 6) states that in his day a coarse reddish sugar was obtained by boiling the juice mixed with lime. When distilled, *tari* becomes spirit or *arak* and finally vinegar (see p. 1111). The methods of collecting the juice and the manufacture of its products differ very little, however, from those employed with other palms. (See **Borassus flabellifer**, pp. 170–1; Cleghorn, in *Edinb. New Phil. Journ.*, n.s.,1861, xiv.) Incidentally it should be observed that in Bengal the cocoanut-palm is not tapped for toddy but in Bombay this is an important industry, although very little sugar is made from it. It may be noted that *jaggery* is not infrequently mixed with lime to make a strong cement which

Jaggery.

takes a fine polish. This is especially noticeable in Madras. [See **Cements**, pp. 293, 929.] The word *jaggery* is the trade name in India for all crude unrefined sugar, though mostly palm sugar. It comes from the Sanskrit *sarkará* (sugar) through the Konkani *sakkara*, the Malayal *chakkara* and the Portuguese *jagara* or *xagara*. [For *Indian Palm Sugar*, see **Phœnix**, pp. 886, 929.]

Desiccated Cocoanut.

The uses of desiccated and shredded cocoanut in European cookery and confectionery, etc., are well known, and need not be particularised. This trade is comparatively a modern one, and might be almost characterised as the chief aspect of European interest in the edible products of the palm. Many patent machines and processes have been brought out, and large factories organised in Europe and America (none in India) for the production and sale of desiccated cocoanut and the manufactures therefrom. It would appear that the growth of this special trade is so important that it is curtailing the export of cocoanuts (entire fruits) from America.

Porcupine-wood.

Timber.—The wood is commercially known as "Porcupine-wood," and is used for rafters and for other building purposes. It makes very pretty and durable furniture, and is also converted into spear-handles, walking-sticks and other fancy articles. [*Cf.* Gamble, *Man. Ind. Timbs.*, 1902, 739.]

Hukah-bowls.
Carved Vases.
Violin.
Cocoanut Pearls.
Matting.

Domestic and Sacred Uses.—By Hindus the dried shell is almost universally used as the water-bowl of their smoking-pipe or *húkah* (hence the name *narghili*); less frequently it is the sounding-drum of crude violins. In Madras the shells are made into elegantly carved ornamental vases, lamps, spoons, sugar-pots, teapots, and small unripe ones into snuff-boxes, scent-bottles and the like. Entire shells are obtained by filling them with salt water and burying them in sand. By this process the kernel is destroyed and may be washed out, but the shell will rot quickly unless the nut so treated be fully ripe. [*Cf. Ind. Art at Delhi*, 1903, 133, 169, 196, etc.; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 116.] According to the Emperor Baber (*Memoirs* (Leyden and Erskine, transl.), 327) and the Emperor Akbar (*Ain-i-Akbari*, 1590 (Blochmann, transl.), i., 71) the shell of the cocoanut was even then used to make a kind of violin or mandoline called *ghichak*. Within the nut there is occasionally found a small stone of a bluish-white colour called in India *calappa* and regarded by the Chinese as a valuable amulet. These "cocoanut pearls" are very carefully described by Rumphius. They appear to be composed almost entirely of calcium carbonate and have a very small proportion of organic matter. The leaves of the palm are serviceable for thatch, screens, baskets, matwork, etc.

Trade.

TRADE IN COCOANUT PRODUCTS.—No sort of estimate can be furnished of the area under this palm or of the total production. The trade returns are moreover scattered under several separate headings, so that a fairly complete statement of even the exports cannot be framed. It will be convenient, therefore, to take up the more important products of the palm separately:—

Fibre.

Exports, Raw Coir.

Coir.—Fibre, Rope and Manufactures therefrom. In trade statistics the exports are shown under the headings "unmanufactured coir," "manufactured coir" (exclusive of rope), and "cordage and rope" (including hemp and coir but excluding jute). The *EXPORTS OF RAW COIR* to foreign countries manifested a steady increase from 1894 to 1900. In the latter year they stood at 70,016 cwt., valued at Rs. 5,65,625. But since 1900 they have greatly fallen off, having been only 25,500 cwt., valued at Rs. 2,26,626, in 1903-4, and 11,317 cwt., valued at Rs. 1,06,634, in 1906-7. This circumstance may be due to increased traffic in manufactured coir (rope matting, etc.), to increased exports in made-up mats or rugs (not returned as coir at all), or to certain rearrangements in official statistics.

Manufactured Coir.

Of the *MANUFACTURED COIR* (excluding cordage and rope) the exports manifest a satisfactory improvement, the traffic for 1903-4 having been returned at 483,355 cwt., valued at Rs. 47,90,110, and for 1906-7 at 559,329 cwt., valued at Rs. 56,00,268. Almost the whole trade is in the hands of the merchants of the Madras ports, the receiving countries being the United Kingdom and Germany. Madras Presidency also supplies the other provinces of India with coir and coir manufactures. These internal transactions were in 1905–6 valued at 15 lakhs of rupees. As already indicated, coir cordage and rope cannot be ascertained separately from hemp, but the total transactions for all India in 1905–6 were 139,870 cwt., valued at Rs. 15,21,131; almost three-fourths went from Madras ports, and hence were in consequence chiefly coir (see **Ropes and Cordage**, p. 924). The imports of coir are unimportant, and come mainly from Ceylon and are consigned to Bengal.

Madras.

Copra and Oil.

Copra and Oil.—The exports of *copra* to foreign countries in the five years 1899–1900 to 1903–4 show a remarkable increase. They stood at 97,029 cwt., valued at Rs. 9,89,377, in 1899–1900; and reached 353,724 cwt., valued at Rs. 42,24,614, in 1903–4; but fell to 126,454 cwt., valued at Rs. 18,95,341, in 1906–7. Of this last amount 125,129 cwt., valued at Rs. 18,76,172, went from Madras ports. The chief recipients were France and Germany. The coastwise traffic in *copra* in 1905–6 amounted in all to 184,066 cwt., valued at Rs. 24,37,736. Bombay sent 47,218 cwt. chiefly to Sind, and Madras 134,546 cwt. chiefly to Bombay. The imports of *copra* from foreign countries have been steadily diminishing and are now unimportant. Statistics of the trade in Indian cocoanut cake are not obtainable separately from those of other kinds of oilcake. The traffic in cocoanut oil to foreign countries in the five years 1899–1900 to 1903–4 increased from 2,245,502 gals., valued at Rs. 27,79,669, in 1899–1900 to 3,379,631 gals., valued at Rs. 48,81,588, in 1903–4; [illegible]t the trade is subject to extreme fluctuations, and fell in 1906–7 to 959,[illegible]2 cwt., valued at Rs. 14,17,794. The United Kingdom and United States are the best customers, and the trade is almost entirely in the hands of Madras merchants. The imports, chiefly from Ceylon and Mauritius, amounted to one million gals. in 1899–1900, but were only 999,556 gals. in 1906–7 and very largely from Ceylon. In the last-mentioned year Bengal received 731,281 gals. and Madras 171,215 gals.

Exports.

Imports.

Madras.

Nuts.

Nuts.—The exports of whole cocoanuts to foreign countries, though still small, show a tendency to increase. In 1899–1900 the total stood at 175,250 nuts, valued at Rs. 5,439; in 1902–3 it was 705,535 nuts, valued at Rs. 24,789; and in 1906–7, 365,890 nuts, valued at Rs. 13,853. Natal and Turkey-in-Asia are the chief receiving countries. The coastwise traffic in nuts is very considerable. In 1905–6 the total for all provinces was 81,920,724 nuts, valued at Rs. 25,50,384. Madras is of course chiefly responsible, having exported to Bombay 61,862,664 nuts, valued at Rs. 18,95,327. The imports of nuts from foreign countries amounted in 1906–7 to 10,975,127 nuts, valued at Rs. 4,98,090, and these came chiefly from the Straits Settlements, the Maldives and Ceylon. Bengal took 4,656,504 nuts, valued at Rs. 1,25,325, whilst Burma received 6,090,728 nuts, valued at Rs. 3,64,546.

Madras.

Desiccated Cocoanut.

India has not as yet figured in the returns of the world's traffic in either desiccated cocoanut or in cocoanut butter.

D.E.P., ii., 460–91. Coffee.

COFFEA ARABICA, *Linn.*; De la Roque, *Voy. Arab.*, 1708–10, 2 pl.; Jussieu, *Mem. de l'Acad. des Scien.*, 1713 (repub. *Hist. Coffee*), 1715; Ellis, *Hist. Acc. Coffee*, 1774 (admirable plate); Plenck, *Ic. Pl. Med.*, 1789, pl. 130; Wight, *Ic. Pl. Ind. Or.*, 1840, i., t. 53; Richard, *Tent. Fl. Abyss.*, 1843, i., 349; Oliver, *Fl. Trop. Africa*, 1877, iii., 180; Baillon, *Hist. des Pl.*, 1880, vii., 275–7, 405; Deflers, *Voy. Yemen*, 1889, 143; Raoul, *Cult. du Caféier*, 1894; Heuzé, *Les Pl. Indust.*, 1895, iv., 172–92; Saenz, *Memo. Cult. del Cafeto*, 1895; Lecomte, *Le Café*, 1899; Foreman, *Philippine Islands*, 1899, 337–42; Marcel Dubard, *Les Caféiers*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. 1, 92–100; also in *Bull. Mus. Nat. d'Hist. Nat.*, 1907, 279–83; RUBIACEÆ.

Kahwah.

Bun.

Original Acceptation.

The names given to the plant, its fruits, its seeds and the beverage prepared from these, are mostly derived from either of two words:—"*kahwah*," an Arabic term that originally denoted "wine," and "*bun*," the Abyssinian name for the coffee plant or its beans. From these we have *cahua*, *kawa*, *chaube*, *kapi*, *cáve*, *kava*, *café*, coffee and *caféier*; also *boun*, *bun*, *ban*, *ben*, *bunu*, *buncha*. The earliest Arabic writers, however, used the Abyssinian name by itself or in combination: thus Avicenna (11th century) calls it *buncho* and Rhases *bunco*. It was by them viewed as a medicinal plant and one very possibly that came from Abyssinia, so that the appearance of the Arabic name *kahwah* may with safety be accepted as marking the progress into the final development as a beverage. The association with wine may be considered in fact as indicative either of the abhorrence of the zealous followers of the Prophet of anything that savoured of the prohibited alcohol or taken as the direct expression of the curious circumstance that when the coffee beverage was first made known to the Arabs it was in all probability distinctly alcoholic, and thus fully deserved the name *kahwah*.

Habitat.

Distribution.

Habitat.—The true coffee plant would appear to have been satisfactorily established by botanists as indigenous to certain hilly regions of Abyssinia, of the Soudan, of Guinea and of Mozambique. Some doubt still, however, prevails as to its being indigenous to Arabia, though this was claimed by the early writers. Richard throws out the suggestion that it may have been indigenous to Arabia, and carried from thence to Abyssinia. It is certainly extensively cultivated in that country, as for example at Enarrea, Kaffa and Harrar. But Richard adds (as if in part support of his view) that coffee is only used by the Muhammadans, not by the Abyssinians proper. Deflers, on the other hand, speaks of the plant as cultivated in Attara and elsewhere on the mountains up to alt. of 7,000 feet, but as nowhere seen wild in Arabia. These two botanical writers thus take opposite sides in the story of the Abyssinian conquests. Richard believes that coffee was carried back from Arabia, and Deflers that it was conveyed to Arabia, about 100 years before the birth of Muhammad. Raynal, Lecomte, and many authors accept the opinion that the plant was taken from Abyssinia to Yemen.

History.

Roasting the Beans.

Succulent Rind.

History.—If we turn to Arabic literature for confirmation of this view we learn for certain that coffee is not mentioned in the *Koran*, nor of course is there any allusion to it in the Hebrew Scriptures. Thus if the plant be viewed as indigenous to certain tracts of Arabia, it becomes necessary to believe that its merits (if known at all) were appreciated within a very restricted area. Everything, in fact, points to the conviction that the people of Mecca, Medina and Bagdad did not know of coffee till well into the 14th century of the Christian era. Ibn Baithar, born at Malaga and who travelled during the 13th century in North Africa and Syria, makes no mention of coffee. The art of roasting the beans and preparing from these a decoction was apparently a more recent discovery, and one which may have been made in Persia. Prior to that, the *kahwah* that first attracted attention, was a preparation from the succulent rind or pulp of the coffee-cherry. This contains a fair amount of sugar, is often pleasantly enough flavoured, and if a decoction made from it were allowed to stand for some short time it would for certain become alcoholic and might even be distilled into spirit.

Egypt. Beans. Husks used. Crystallised Coffee-cherries. Roaster. **India.** **Arabia.** Stimulating Drink.

Giovan Leone, who visited Egypt in 1513 and wrote a careful account of Cairo, makes no mention of the consumption of coffee, nor is the plant enumerated in his list of the most useful and novel African plants. On the other hand, seventy years later, Prosper Alpinus (*De Pl. Ægypti*, 1592, 26) speaks of the *bon* tree seen by him at Cairo in the conservatory of an Egyptian gentleman, and further he gives full particulars of the decoction, called *caoua*, which he says they prepared from the seeds imported from Arabia Felix and sold in public taverns, in place of wine. In his other work (*De Medecina Method.*) Alpinus remarks that some of the Egyptians used the husks of the coffee-berries instead of the berries themselves. Vesling (in his edition of Alpinus' work published in 1735, 179) adds that coffee-cherries, brought from Yemen, were sold in Egypt as crystallised fruits and regarded as great luxuries. Verzascha (*Kräuter-Buch.*, 1678, 788), while reprinting the account given by Alpinus, speaks of the beverage being served in earthen pots entirely closed up, and adds that the husk makes a stronger infusion than the berries (seeds). The seeds, he observes, are called *bon* and the drink *choava*: he furnishes a picture of a roaster, so that by then, at all events, there would seem no doubt the seeds were regularly roasted and a beverage prepared from them, as well as from the husk. Sandys (*Travels*, 1610 (ed. 1670), 51) alludes to "Coffa-houses" of Constantinople. Pietro della Valle (*Voy. East. Ind.*, 1665) says of coffee, it is "made by a black seed boyled in water which turnes it almost into the same colour but doth very little alter the taste of the water; notwithstanding it is very good to help digestion, to quicken the spirits, and to cleanse the blood." Herbert (*Travels*, 1677, 113, 311) speaks of "Coffe or Coho" as a Persian beverage prepared from "the flower of the Bunny or Choava-berry" and sold in shops. Fryer (*New. Acc. E. Ind. and Pers.*, 1675 (ed. 1698), 225, speaks of "Coho or Tea" as being served at a State ceremonial at which he was present at Bunder Abbas. An apology for mistakes explains that the text was printed in the absence of the author. Hence it may be inferred the "Explanatory Index" was not drawn up by Fryer. In that index "coffee" is given as the equivalent of *coho*. It is thus probable that Fryer himself accepted *coho* as a name fully understood in England. It is of course a variant of the Arabic *kahwah*, which originally denoted the wine prepared from the husk of the coffee-cherry, not the beverage of the roasted seeds. Niebuhr (*Voy. Arabia*, 1770) says that in Yemen coffee made from the seeds is supposed to heat the blood; accordingly the inhabitants of that province compose a drink of the hulls of coffee which in taste and colour much resembles tea. This they esteem wholesome and refreshing. It is prepared nearly in the same manner as that from the seed or bean and is the *coffée à la Sultane* of the French. Deflers observes, "It is well known that the pericarp of the fruit dried in the sun and powdered constitutes the product used under the name of *qischr* for the preparation of a stimulating drink rather like an infusion of tea." "Aromatised with ginger or other spices it is with *qat* the favourite stimulant of the Arabs of Yemen who abstain from the use of coffee prepared from the seed, ground in the Turkish and European fashion."

Abyssinia.

Turning now to a few of the records regarding Abyssinia: Richard, as already observed, affirms that coffee was not in his time much used by the Abyssinians. Nearly all was taken to Messoah by caravans and from thence dispatched to Moka, where it was sold as Arabian coffee. Henri Lecomte gives a very different account: "From time immemorial the Gallas have used coffee both as food and drink. Originally they made a decoction of the beans and pulp cooked together. The system of roasting was only discovered later."

Coffee of Roasted Seed. Aden. *Kát.*

Such then are the observations of early travellers in Arabia, Abyssinia and Egypt, and these may now be linked up with the prevalent opinions and traditions. Coffee made of the roasted seeds would appear to have been first brought prominently to notice at Aden. It was known for centuries previously as a drug, and many of the Arab writers speak of having been made acquainted with its properties through the Persians. Abu Abdallah Muhammad Dhabbani Ibn Said had occasion to visit Persia (according to Galand, Roque and Ellis: Africa, according to Yule and Burnell: lastly Abyssinia according to the authors of the *Pharmacographia Indica*) during the 15th century. On that occasion he found the faithful partaking of coffee. Returning to Aden he took to drinking coffee himself, and recommended his followers to substitute that beverage for the *kát* (***Catha edulis***) which they were in the habit of using. Vaughan (*Pharm. Journ.*, 1852, xii.) gives further particulars regarding Muhammad Dhabbani, but throws no light on the country whence he obtained his knowledge, nor does de Sacy deal with this issue. From Aden, however, the knowledge seems to have spread

Coffee-drinking repressed.

Pulp of the Cherry.

Roasted Seed

to Mecca, Medina and Cairo, and finally within the century after its introduction to Aden, it had been conveyed to Damascus, Aleppo and Constantinople. But in due course the more strict in the tenets of their faith objected to public coffee-houses and to the gaming, singing and dancing that there took place. At various times the effort was accordingly made to repress the traffic and to close the coffee-houses. In 1511 the Governor of Mecca (the Viceroy of the Sultan of Egypt) issued a " Condemnation " of coffee as the united opinion of the priests, doctors and learned men of that town, on the ground that it was a form of wine (*kahwah*) and therefore contrary to the law. It is thus just possible that the beverage then in use was prepared from the pulp of the fruit and was, therefore, actually intoxicating. But the Sultan revoked the condemnation and reproved his viceroy for venturing to prohibit an article of daily food used by the people of the capital of the Empire (Cairo) and by the Sultan himself. Later on (1524), however, the coffee-houses of Mecca had become the scenes of so much rioting that they were closed, by order of the Kadi. In 1533 the people of Cairo were divided into two classes, those who considered coffee lawful, and those who did not. In 1554 the coffee-houses of Constantinople were closed on a new pretext, that possibly marks the more complete establishment of the habit of roasting the seeds. The charred berries (seeds) were considered as charcoal, and thus unlawful as articles of food.

European Knowledge.

First Botanical Description.

Difference of opinion exists regarding the first European who saw and described both the plant and the beverage. Ramusio published in 1554 his *Raccolta delle Navigationi e Viaggi*, and one of the travellers whom he quotes describes a journey from Aden to Rhada which he made as a prisoner. Incidentally he mentions coffee among the plants observed by him, but speaks of it as if he and all his readers were perfectly familiar with the plant so named. We know that by that time it was being used in Constantinople, so apparently it was known some time prior to the actual date of its being chronicled. De la Roque, while characterising the traffic in coffee as quite modern, points out that Peter Belon, who travelled in Egypt and Arabia in 1546–9 and described most of the curious and interesting plants seen by him, makes no sort of allusion to coffee. But about the same time, or shortly after, several other travellers visited both Arabia and Abyssinia, and some mention while others are silent regarding coffee. Similarly John Ray published in 1693 a collection of Voyages and Travels. A few of the authors whose works he gives, deal with Ethiopia and Arabia, and some mention coffee while others do not. Clusius (*Arom. Hist.* (Garcia de Orta), 1574, 214–5) received from Dr. Alphonse Pancius of Ferrara, during the summer of 1573, a few coffee-berries (seeds). These he figured and described, and tells us that they were called *buna* and by some *elkaue* (*al kave*) and that in Alexandria a drink was made from them. Rauwolf visited Aleppo in November 1573 and saw the coffee plant, as also the beverage. He published his account in 1583 (*Beschreib. der Raiss.*, 103). Thus Clusius, not Rauwolf, as is commonly affirmed, should be viewed as the first botanist who examined and described the coffee-berries. Prosper Alpinus, as already stated, had a few years still later given a full account both of the plant and of the beverage, and his statements were published time after time for a century subsequently, without any new information of value being made known.

Early Coffee Trade.

Very few of the early rulers, travellers or botanists of India mention coffee, such as Marco Polo (1290), the *Memoirs* of the Emperor Baber (1519), the *Ain-i-Akbari* (1590), Rheede (1678), and Rumphius (1750). Linschoten (1598) described the preparation of tea in Japan, and his contemporary and publisher Paludanus, in a footnote commenting on that passage, observes that in the same way the Turks prepare a beverage from " the fruit which is like unto the *bakelaoe* (laurel berry) and by the Egyptians is called *bon* or *ban*." Pyrard (*Voy. E. Ind.*, 1610 (ed. Hakl. Soc.), i., 172) speaks of the king and great lords of the Maldives drinking coffee. Tavernier (*Travels Ind.*, 1676, ii., 23–4) says that in his time coffee did not grow either in India or Persia, but that the supplies came from Arabia. He then adds that the principal coffee trade was from Hormuz and Bassora, "where the Dutch when returning empty from Mocha, load up as much as they can with that seed, it being an article which they sell well." From Hormuz it is exported to Persia, and from Bassora to Mesopotamia and other Turkish provinces. (*For accounts by Bontius, Mandelslo and Ovington, see* **Camellia**, p. 212.)

Coffee-drinking.

Down to the year 1690 the world's supply of coffee came from Arabia and Abyssinia. The following historic data may be accepted therefore as fittingly con-

In Venice.

In Leghorn.

In London.

In Oxford.

In Paris.

Cultivation in Europe.

In Mauritius.

cluding this brief statement. In 1615 coffee-drinking was carried to Venice. In 1644 Peter della Valle took it to Marseilles. John Houghton (*Phil. Trans. London*, 1809, iv., 420) says that Rastall, an English merchant, went to Leghorn in 1651, and there found coffee-houses. In the year following Mr. Daniel Edwards, a merchant from Smyrna, brought to England a Greek servant named Pasqua, who made his coffee. Shortly after Pasqua was enabled to set up a public coffee-house in Cornhill. It is further affirmed by Houghton that Dr. Harvey, the discoverer of the circulation of the blood, frequently used coffee. But Henry Phillips (*Pomarium Britan.*, 1820, 112) says that Nathaniel Conopios, a Cretan, made coffee his common beverage at Baliol College, Oxford, in 1641. This same fact is alluded to by Evelyn (*Memoirs*, 1819, 7) as having taken place in May 1637. In 1675 Charles II., by an ill-judged proclamation, in which he characterised the coffee-houses as seminaries of sedition, endeavoured to close them, but the Act was suspended a few days later. By 1688, according to John Ray, London rivalled the Grand Cairo in the number of its coffee-houses. Lord Bacon (*Sylva Sylvar*, 1658, Century viii., 185), speaks of the *coffa* drink used by the Turks, but he had apparently no personal knowledge of it. In 1657 the Turkish Ambassador Sulaiman Aga made coffee-drinking fashionable in Paris, and in consequence the roasted coffee-berries sold in Paris during 1670 at £5 a pound. It seems probable, however, that through M. Thevenot coffee was definitely introduced about 1667, but that the habit of coffee-drinking was not general in Paris until 1680. In 1690 live seeds having been conveyed to Batavia, a plant was shortly after taken to Amsterdam and in 1712 the Dutch presented a seedling from this to Louis XIV., and still later from that plant seedlings were sent to Martinique. Madame de Genlis (*La Bot. Hist. et Littér.*, 1811, i., 193) tells how M. Deslieux, who went to Martinique in 1720, as Lieutenant of the King, in the same ship with the seedlings, gallantly saved them by depriving himself daily of the greater part of his allotted portion of water—the ship's supplies having run short. He had in consequence the good fortune to see the plants arrive in safety and a new source of wealth thereby added to the island. M. de Candolle, M. Edelestan Jardin and many other writers allude to this incident. In 1723 coffee was taken by the Portuguese to Java; in 1728 Sir Nicholas Laws introduced it into Jamaica, and in 1770 it was conveyed to Rio de Janeiro.

Coffee in India.

First Plantation.

Ceylon Planting.

The history of the introduction of coffee into India is very obscure. Most writers agree that it was brought to Mysore some two centuries ago by a Muhammadan pilgrim named Baba Budan, who, on his return from Mecca, brought seven seeds with him. This tradition is so universally believed in, by the inhabitants of the greater part of South India, that there seems every chance of its being founded on fact. About the beginning of the 19th century there is no doubt coffee had found its way to India, and in 1823 a charter was granted to Fort Gloster, near Calcutta, authorising it to become a cotton mill, a coffee plantation and a rum distillery. Some of the coffee trees planted in fulfilment of that charter are supposed to be still alive, and about the same time coffee was successfully grown in the Botanic Gardens, Calcutta; but needless to say the industry of coffee planting nowhere found an abiding place on the plains of India but migrated to the hills of South India, in Mysore more especially, and thus into the very region where tradition affirms it had been introduced two centuries previously. The first systematic plantation was apparently Mr. Cannon's near Chikmuglur. This was established in 1830. It is supposed, however, that Major Bevan may have actually grown coffee on the Wynaad at a slightly earlier date, and that Mr. Cockburn's Shevaroy plantation bears the same date as Mr. Cannon's. In 1840 Mr. Glasson formed a plantation at Manantoddy, and in 1846 plantations were organised on the Nilgiri hills. In Ceylon it is believed coffee was introduced by the Arabs prior to the Portuguese invasion of that island. It was commenced to be systematically cultivated by the Dutch from about 1690. In 1825 the first plantation by an Englishman was opened by Sir Edwards Barnes. In 1877 it was estimated that the capital invested in Ceylon coffee was close on £14,000,000. The fungal disease (***Hemileia vastatrix***) appeared about 1869 and spread rapidly, steadily weakening the bushes and reducing their yielding capacity, so that by 1887 the Ceylon industry was completely ruined.

It would occupy many pages to give anything like a complete enumeration of even the more important works on coffee. [The following in supplement of those already given in the *Dictionary*, and of those mentioned above, will be found specially worthy of study:—Thevenot, *Travels in Levant, Indostan, etc.* (Engl. transl.), 1687, pt. i., 162–3; pt. ii., 11, 21; Dafour, *L'Emploi du Café*, 1671; also

Le Café, 1684; Spon, *Tract. de Potu Caphé*, 1684; Blankaart, *Coffee*, 1686; Nichol de Blegny, *L'Emploi du Café*, 1687; Galand, *L'Origine et Progrès du Café*, 1699; Chardin, *Voy.*, 1686 (Engl. ed.), 1811, ii., 279; Ray, *Hist. Pl.*, 1688, ii., 1691; Petrus Petitus, *Homeri Nepenthes*, 1689, 73; Sloane, *Phil. Trans. London*, 1693 (ed. 1809), iii., 623; Pomet, *Hist. Gen. des Drogues*, 1694, i., 204; Bruce, *Travels*, 1790, ii., 226; Macpherson, *Comm. with Ind.*, 1812, 271; Milburn, *Or. Comm.*, 1813, i., 104–6; ii., 530; Law, *Hist. Coffee*, 1850; Thurber, *Coffee, Plantation to Cup*, 1881; De Candolle, *Orig. Cult. Plants*, 1884, 415–8; Van Delden Lærne, *Coffee Cult. Brazil and Java*, 1885; Nicholls, *Textbook Trop. Agri.*, 1892, 91–109; *Pharmacog. Ind.*, ii., 215–25; Elliot, *Gold, Sport and Coffee in Mysore*, 1894; Ferguson, *Coffee Pl. Manual*, 1894; Jardin, *Le Caféier et le Café*, 1895; Burton, *First Footsteps in East Africa*, 1894, i., 12 n., 55 n.; ii., 26; Heuzé, *Les Pl. Indust.*, 1895, iv., 172; Semler, *Trop. Agrik.*, 1897, i., 218–24, 233, 260; Laborie, *Coffee Planter St. Domingo*, 1898; Lecomte, *Le Café*, 1899; also in "*La Géographie*," June 1901; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 137–8, 142–5; Morren, *Kaffeeplantage in Der Tropenpflanzer, Beihefte*, March and May, 1900; Mukerji, *Handbook Ind. Agri.*, 1901, 456–62; Lehmann, *Coffee Cultivation, Dept. Agri. Mysore Bull.*, No. 2; Jumelle, *Les Cult. Colon.* (*Aliment.*), 1901, 350–85; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, i., 483.]

Distribution.

Distribution.—The world's supply of coffee, we are thus justified in believing, came originally from Arabia and Abyssinia, but as the demand increased new localities of production were established. The Dutch East India Company pioneered the modern trade by their experimental cultivation in Batavia. Soon thereafter coffee cultivation was successfully introduced into the warm temperate areas (or hilly tracts) of most tropical countries, and in time these not only produced far more than the ancestral regions, but yielded a supply of an even superior quality. Improvements in quantity and quality of necessity rapidly extended consumption until they made coffee one of the most popular of all beverages, and hence with a large number of the inhabitants of the globe it passed from the position of an occasional luxury to that of a daily necessity, rivalled only by tea—the sister beverage of the breakfast table.

Species and Varieties.

Species and Varieties Cultivated.—After the somewhat detailed account already furnished of the chief historic facts regarding the Abyssinian (commonly called the Arabian) coffee plant, it is perhaps hardly necessary to indicate that particular species any further for the present. It is to this day by far the most important cultivated stock, though its liability to blight has caused planters to seek out other forms, in the hope of being able either to replace *Coffea arabica* or to use these as strains in hybridisation or as stocks upon which to graft, in the production of blight-proof plants. In this modern aspect of the coffee-planting industry three plants have attracted special attention. These are:—

Liberian.

(*a*) **C. liberica**, *Hiern*;—a native of West Tropical Africa (Liberia, Angola, Golungo, Alto, etc.). But in its indigenous area it is very indifferently cultivated, at most in but small plots along the banks of the rivers. In trade it is called Liberian or Abeokuta Coffee. Sir J. D. Hooker from 1872 advocated in the *Kew Reports* the cultivation of this plant—it was then being experimentally grown at Kew; Ferguson published a History of its introduction, progress and cultivation in Ceylon up to 1878; Thurber, *l.c.* 107–16; *Kew Bull.*, 1890, 107, 245–53; 1892, 277–82; 1893, 25, 204–6; 1895, 12, 273–4, 296–9; 1897, 314; *Progress Rept. Bot. Gard. Nilgiri Hills*, 1881–2; Christy, *New Comm. Pl.*, 1878, i., 1–7; Lærne, *l.c.* 321; *Trinidad Bull.*, 1894, 267–73; Watson, *Cult. Tavoy*, 1893; *Rept. Govt. Bot. Gard. Bangalore*, 1897–8, 11; Vankeirsbilck, *Rev. Agri.*, 1896, x., 135–7, 162; *U.S. Yearbook Agri. Dept.*, 1897, 197; Huettenbach, *Cult. Liberian Coffee*, in *Selangor Journ.*, 1897; *Der Tropenpflanzer*, 1897, i., 290–6; iii., 231; *Journ. Soc. Arts*, 1897, 541; 1903, 461; *Cat. des Pl. Econ.* in *L'Horti. Colon.*, 1900, 63–4; Edmond Bordage, *Revue Agri. de la Réunion*, 1901 *L'Agri. Prat. des Pays Chauds*, 1902, ii., 169, 624; Sadebeck, *l.c.* 145;

Chief Publications.

Produce World; *Planting Opinion*; *Trop. Agrist.*; *Capital*; *Madras Mail*, etc. etc.

This species was thus first made known to Europe about the time the coffee-leaf disease appeared in Ceylon. Its hardier growth led to the opinion, to some extent realised, that it might withstand the action of the blight, and on this account demands were made on the Royal Botanic Gardens, Kew, for plants or seeds. Fortunately the Director of the Gardens was fully able to satisfy these, until the question of seed supply was taken up by the trade. The *Kew Reports* are full of the most interesting and suggestive details regarding the successes or failures attained through the experiments conducted, almost simultaneously, in all the tropical regions of the globe. But in one respect at least they have been disappointing, namely, the plant, though much hardier than the Arabian coffee, has not proved to possess immunity from blight. In fact Sir Daniel Morris pointed out long ago that in the nursery the seedlings often suffer from ***Hemileia*** quite as much as do those of ***C. arabica***, but he added that the plants, if properly cared for, soon attain sufficient strength to withstand the disease.

Special Cultivation.

Immunity from Disease.

Diseased in Nursery.

The experience gained in India would seem to support belief that Liberian coffee requires quite as fertile and as deep soils as ***C. arabica***. It prefers a warm moist atmosphere and not much less than 100 inches of rain, distributed if possible throughout the year; but it is very susceptible to drought. Where subjected to dry heat, therefore, shade-trees must be provided if they do not already exist. In Java ***Erythrina*** seedlings are first planted, but soon give too much shade and are accordingly replaced in about five years' time by ***Eriodendron*** seedlings.

Warm Moist Locality.

Shade-trees.

A shallow soil or one with a large admixture of sand and stones is quite unsuited, as also are heavy clay soils and waterlogged subsoils. But Liberian coffee luxuriates on moisture-retaining soils and on lands that can be, and are regularly irrigated. It, in fact, prefers low-lying tracts to high ground, and accordingly flourishes better on the plains than on the hills. It is true that on the Wynaad and elsewhere it has been successfully grown up to altitudes of 5,000 feet, but that circumstance does not materially detract from the opinion that it is better suited to the plains of the tropics than ***C. arabica***. Hence Liberian coffee has attained its most extensive production in the West Indies, Ceylon, the Malay Peninsula (Selangor), North Borneo, Sumatra and Java, and in India seems likely to attain its chief production in Sylhet, Assam, Burma and the Andaman Islands. Lærne says that it is "little thought of" in Brazil, since "it produces little and that irregularly." On the east-coast lands of Madagascar it has for some years been fairly extensively cultivated. M. Deslandes, Assistant Inspector of Agriculture, says that the plants there grown are hybrids and yield a berry superior to that of African coffee. Being large plants the custom exists of allowing them plenty of space, say 400 trees to the acre. There are several distinct races, some that form much larger plants than others and accordingly require more space. It is just as important with Liberian as with Arabian that the races of the plant should be critically studied. For some years past numerous hybrids have been cultivated all over the world. In the south such have appeared wherever Arabian and Liberian coffee were grown side by side. The stock thus obtained is much valued by many planters, being regarded as enjoying immunity from leaf-blight. But it is usually contended that for young colonies, Liberian has distinct and superior claims. It yields regularly and freely, the fruits do not fall so readily from the bush on their reaching maturity, and it is, when all is said and done, a much hardier plant than the Arabian coffee. On low ground the harvest is abundant, the fruits are large (nearly twice the average size of the Arabian bean), not so delicately flavoured, though of good quality when grown on high altitudes. The berries are more difficult to clean than are those of the Arabian plant, but with proper machinery may be completely deprived of even the parchment; they are rank and oily, though if carefully and slowly dried will fetch a price sufficient to reward all the trouble and expense entailed. According to most writers a drawback to this coffee lies in the fact that it has never been pushed as a commercial commodity on its own merits. The beans seem universally used by middlemen for the purpose of strengthening grades which by themselves would be flavourless.

Low Land.

Madagascar.

Four Hundred Trees to the Acre.

Hardier Plant.

Berries difficult to clean.

(*b*) **C. stenophylla,** *G. Don*; *Bot. Mag.*, 74–5 and t.; *Kew Bull.*, 1893, 167; *Rept. Bot. Gard. Bangalore*, 1893–4, 10–11; 1896, 189–91; 1898, 27; *Rept. Roy. Bot. Gard. Trinidad*, 1896, 13; 1900, 12–3; *Pharm. Journ.*, 1897, 17; Semler,

Sierra Leone Coffee.

Area

Hybrids.

Highly Flavoured Berry.

Trop. Agrik., 1897, i., 217; *Der Tropenpflanzer*, 1898, ii., 34, 263; *Trinidad Bull., etc.*, 1899, 223; 1900, 315; *Agri. News, West Indies*, 1902, i., 278; ii., 237; *Journ. Soc. Arts*, 1903, 461; *Trop. Agrist.*; *Planting Opinion*; *Madras Mail*, etc., etc. "The Highland Coffee of Sierra Leone." This interesting West African species, Mr. Bentham thought, might be but a variety of ***C. arabica***. The seeds were issued from Kew Gardens, and the plant is now being experimentally grown in Trinidad, Java, Ceylon, Mysore (not successfully) and elsewhere. Hybrids have also been formed between it and ***C. arabica***, as also ***C. liberica***. It grows freely, yields abundantly, but is longer in coming into bearing than ***C. liberica***. It gives a highly flavoured Moka-like berry.

Congo Coffee.

Loves Moist Situations.

(*c*) **C. Laurentii,** *Wildem.* (**C. robusta**, *L. Linden*), is another tropical African species that has attracted some attention, though it is but imperfectly known botanically. It is spoken of as "Congo Coffee." An article appeared in *L'Horticole Coloniale* (*l.c.* 64–6) in the year 1900 that gives a good account of this plant. It is spoken of as prolific, as almost immune from the ordinary diseases of coffee, and as yielding a berry of a superior quality with a delicate aroma. It frequents banks of streams and prefers situations moist and not too shady. The plant is not, like ***C. liberica***, pyramidal in shape, but is rather rounded in outline. Jumelle (*Les. Cult. Colon.* (*Aliment.*), 1901, 350–85) adds that it inhabits Sierra Leone, on soils formed of decomposed granite or gneiss. Owing to its having been first made known from the Nunez river it is often called "Rio Nunez Coffee." In India and Ceylon this plant has so far failed to justify extended endeavours, but in Dominica the results have been most encouraging.

CULTIVATION.

Localities.

Indian Area.

Fluctuations.

Brazil.

Localities and Area.—In this work it is desirable to restrict observation to India, and consequently to allude only incidentally to the coffee-growing of other parts of the world. Particulars of cultivation in Java, Sumatra, Philippines, Ceylon, Queensland, Brazil, West Indies, Central America, Mexico, etc., will be found in the respective chapters of Thurber's *Coffee from Plantation to Cup* and other such works, to which the reader is referred. The actual area under the crop in India cannot be stated definitely, owing to the unwillingness of certain planters to furnish information. The error that exists is, however, a relative one, and tends year after year to be lessened rather than increased. Taking the official returns as they stand, it has to be accepted that the area shown under coffee, during the past thirty years, has manifested severe fluctuations. With a perennial crop this can alone denote the fallowing or abandonment of certain plots and the resuscitation of old plantations or the opening out of new lands, coincident with variations in the world's coffee necessities. Thus, for example, the revolutions that took place in Brazil in 1889, 1891 and 1893, followed as these were by small crops during one or two of the succeeding years, had a highly beneficial effect on the Indian coffee-planting industry. The area returned as under coffee in 1885 stood at 237,494 acres, but for the ten years ending 1895 the mean area in India was 274,000 acres; in 1903, 228,815 acres; and in 1904, 212,964 acres. The latest report of the Commercial Intelligence Department states the area at the end of 1906 to have been 210,688 acres. During the decade ending 1895 prices may also be said to have ruled high, so that the industry was very prosperous.

In addition to the absence of returns as to certain plantations, an estimate of yield to acre could hardly be accepted as even of general application. It accordingly follows that trade statistics almost invariably manifest higher exports than the agricultural data would show as produced. The relation of surveyed areas to actual returns of foreign exports is one of the most profitable aspects of study. Taking 100 to represent the area as also the exports in 1885, the following variations have occurred, every fifth year being selected:—1885, area 100, exports 100; 1890, 114 and 63; 1895, 120 and 78; 1900, 115 and 66; 1905, 90 and 97; and 1906, 89 and 61. (See prices, p. 391.)

Production.

Production.—The coffee produced in India is practically all exported, the most important markets being the United Kingdom and France, so that the returns of trade afford a useful check on the figures of production. The year of highest export was apparently 1885-6, when 41 million lb. were shipped, or about 6 million lb. in excess of the year's production. Some ten years later (1895) (the record year of production) the exports came to 32½ million lb., or 7½ million lb. less than the recorded production.

The official year of trade returns being from March 31, and that of the agricultural statistics the calendar year, a certain overlapping of data of necessity occurs, and, moreover, reserve stocks over local consumption are usually drawn upon before the new crop comes into market. But taking it all round, the particulars of area and production are substantiated by the actual records of the trade.

Distribution of Areas.

Of the total area, 28,089 acres (according to the Report of the Commercial Intelligence Department) were under immature plants in 1906, so that in the future these will come into bearing and enhance the yield, very possibly to a greater extent than the reduction due to the age and disease of the plants presently returned as mature. In passing it may be here observed that in addition to the actual area under coffee, the planters own 108,581 acres, much of which is available for future expansion should such be found desirable. Analysing the area of production according to the report for 1906, we learn that out of the actual area recorded (196,318 acres), 89,202 are in British India and 107,116 in Native States. *Of the former*—42,646 acres are in the Madras Presidency; 46,393 acres in Coorg; 74 acres in Bombay Presidency (Kanara district mainly); 84 acres in Assam (South Sylhet mainly); and 5 acres in Burma. *Of the latter*—101,489 acres are in Mysore, and 5,627 acres in Travancore and Cochin collectively. If we disregard the isolation into British and Native we learn that the coffee outside the Madras Presidency is ordinarily only about 0·15 per cent. of the total Indian area. It would thus be quite safe to describe Indian coffee-planting as an industry confined to the Madras Presidency. The chief localities are Mysore, Coorg, the Wynaad, the Nilgiri, Pulney and Shevaroy hills. The most important districts are Kadur and Hassan, both in Mysore, Coorg, and the Madras Presidency proper.

Distribution.

British Districts.

Native States.

Persons Employed.

Yield.—On December 31, 1906, there were in all India 31,827 plantations, which gave employment to 24,477 persons permanently and 46,044 temporarily. These figures show a considerable reduction on the previous year, when there were 43,233 plantations. Dividing the figure of area by that of production and striking the mean of all the returns for some years back, the Indian yield would appear to be a little over 100 lb. to the acre, but it fluctuates very greatly; thus in 1903 the yield would appear to have been 139 lb., while in 1901 it was only 65 lb. It is probable, however, that in all the larger and better-worked plantations an average yield of 2 to 3 cwt. is usually obtained, in European plantations, and ¼ to 1 cwt. in Native. But even that average is misleading, since it is well known some of the better plantations may yield as much as 7 to 10 cwt. an acre. Hence the officially returned acreage divided by the declared production, since it involves a mean of good, bad and indifferent results, cannot

Yield.

be accepted as a method of deriving the yield, though the figures thus produced are suggestive and have, therefore, a certain value.

Climate.

Temperature.

Humidity.

Climate and Situation.—It has been said, and with much force, that a good deal of land at one time and another has been opened under coffee that was never suited to it. Of this nature are some of the Coorg estates (or portions of them) that have a southerly aspect and are exposed to the full force of the east winds. Situation and exposure are factors of prime importance. It seems to be the Indian experience that coffee prefers land standing from 1,500 to 5,500 feet above the sea-level, the exact altitude being controlled to a large extent by latitude. Far to the south higher altitudes would seem necessary than in the more northern tracts. The temperature best suited would appear to range from 55° to 80°. The total rainfall should not exceed 150 inches but about 100 is the amount most frequently commended, provided it be fairly evenly distributed throughout the year; but December to March may be dry. Coffee distinctly requires a humid atmosphere, and in the opinion of most planters the prevalence of heavy winds are more objectionable than a dry atmosphere or a low rainfall. The climate must be open and bracing and the sky not heavily overcast. With *C. arabica* low-lying and damp situations induce disease. As already mentioned, however, altitudes lower and warmer than those indicated for *C. arabica* are suited for *C. liberica*, but even with that species the higher limits of its production give the most valuable berry.

Situation.

Soil.

Ferruginous Loam.

Rocky Soil.

Manured Soils.

Soil.—Coffee, although very largely a surface feeder, has a long tap-root which it is most desirable should not be injured during transplanting. The success of the crop depends to a large extent on the depth of the soil. The best soil might be described as a well-drained, ferruginous loam, though certain clays mixed with sand give good results, especially if a fair amount of humus be present or be given as top-dressing. Very chalky soils, as also stiff clays, are useless. It is usually held that soils that contain a fair amount of iron give the best-flavoured berries. But below the subsoil there must rest a bed of very porous material so as to ensure ready drainage. In fact a rocky soil with pouches of loam between the outcropping rocks gives admirable results, as may be seen in many parts of the Shevaroys, the Nilgiris and the Wynaad. The rocks are constantly weathering and thus adding to the soil, while, according to the planters, they also transmit the heat and moisture. [*Cf.* Robinson, Pringle, Voelcker, Lehmann, Leather, etc.] It is, however, unfortunate that no record has been kept of the conditions of land opened out and of the same fifteen or twenty years afterwards, both in estates manured and in those not manured.

Nursery.

Sand.

Mould.

Watering.

PROPAGATION.—Nursery.—Having selected the site for a plantation, cleared and burned (or piled up in ridges to await natural disintegration) all the trees not deemed necessary for shade purposes, laid out the roads and carried a water supply to the coffee-house, the next most urgent task is to select and prepare the site for the nursery. This must never be on an old coffee plantation, but on virgin ground of sufficient richness that manuring may not be necessary except to add sand with a view to securing its porous nature. But the soil of the seed-beds must be rich in vegetable mould, bear a gentle slope, be well drained, retentive of moisture, and liberally supplied with water for irrigation purposes, since for some time watering is necessary. If not already secured, provision should be made for shade against the severity of the sun, but drip from protecting trees must be avoided by seeing that they are at a sufficient distance from the seed-beds. The beds should be slightly raised and of a breadth to allow of hand dressing from the dividing paths. In many cases temporary shelters may have to be constructed over the beds. A deep trench had better also run along the top of the entire nursery so as to check the possibility of surface wash.

Shade.

Trench.

Varying Methods.

The reader should consult the *Dictionary*, and one or other of the technical reports, cited above, for details of the coffee industry. For example, the varying methods of sowing, transplanting, weeding, pruning, etc., which to some extent are peculiar to each locality, must be sought for elsewhere. All that can be attempted in this work is a review of the facts that are deemed likely to have a bearing on the stability and prosperity of coffee planting.

Selection of Stock.

Selection of Stock.—One of the most important of all tasks is the decision as to the stock to be grown. Even if the choice has been made of Arabian in preference to Liberian, there still remains the selection of the race or hybrid desired, and the source of supply. The reputation of the seed estate, the age of the parent stock (seven to ten years preferably), the method of treatment of seed, etc., etc., are points of vital importance. The seed should be gathered from healthy plants, the cherries should be fully ripe before being plucked, then hand pulped after maturity, and lastly they should be washed and dried in the shade in such a fashion as to avoid both fermentation and undue drying of the kernels. In fact some planters believe that seeds fresh from the trees should be husked and instantly sown to obtain the best results. The talk of "male" plants and the discussion as to the value of pea-berry as seed, are themes indulged in at the expense of infinitely more valuable topics, but the greatest mistake of all is to suppose that coffee is coffee and that both seed and seedlings may be picked up anyhow or anywhere.

Age of Parent.

Seed should be washed.

Pea-berry.

Races.

Races and Hybrids.—M. Jumelle (*Les Cult. Colon. (Aliment.)*, 1901, 352–3) mentions many forms of coffee (apparently all races of *C. arabica*) and his enumeration may be here quoted as suggestive, since some of the races mentioned are already known to the Indian coffee planters. He treats of Moka as the stock typical form of the species and adds:—

(*a*) **Vermelho.**—A red-fruited coffee much grown in Central America: it is more robust than the type.

(*b*) **Amarello** of Brazil.—A yellow-fruited plant rich in cafeine but rather bitter in taste.

(*c*) **Maragogipe.**—The Upland Brazilian coffee, which has seeds nearly as large as Liberian coffee and is very prolific. This form appears to have been introduced into South India and is often referred to by planters, but no one appears to have furnished a report of its special merits or of the success attained with it in India. According to some writers this is a hybrid between *C. arabica* and *C. Laurentii*. [*Cf. Kew Bull.*, 1894, 163–4; *L'Horti. Colon.*, 1900, 62–3; *Agri. News W. Ind.*, 1903, ii., 316–7.]

(*d*) **Leucocarpa.**—A white-fruited plant found originally in Sierra Leone. Could this be one of the special species of that country and not a cultivated race of *C. arabica*?

(*e*) **Soufrière.**—A very hardy plant that resists insect pests: the leaves are like those of the type but the seeds much larger.

(*f*) **Leroy of Reunion or Pointed Bourbon.**—Is more hardy than Moka, has short branches crowded with leaves, and the seeds are pointed at one end.

(*g*) **Mysore.**—Commercially described as "Cannon's high-priced Mysore." Has round heavy seeds; the branches are ascending; but as the yield is irregular it is being replaced by the next form.

(*h*) **Coorg Coffee.**—This has large flat seeds and is propagated easily. There are several well-marked races such as the "Chick," "Golden Drop," "Nalknad," etc.

(*i*) **Java Coffee.**—This bears branches less horizontal than Brazilian, and the two young leaves at the extremity of the shoots are greenish-yellow in the Javan, and brownish-yellow in the Brazilian plant.

Indian Forms.

The planters of India recognise many more distinct races, but as no one seems to have scientifically described these, and the writer's personal acquaintance with the coffee plant was acquired during one or two very rapid tours of inspection, he is unable to attempt a description or classification of the special Indian races and hybrids. The reader would do well, however, to consult Mr. J. Cameron's various reports on the experiments conducted at the Lal Bagh of Bangalore. He will discover that Cameron discusses the hybrids that have been produced naturally, and explains that their most remarkable feature is their immunity from leaf-disease. But he has apparently not been so successful in the production of crosses as has been the case in other parts of the world. All the same his conclusions on this issue are clear and definite. He is sanguine that hybridisation may be looked to as likely to afford much advantage. The renovation of coffee, he accordingly adds, is "not wholly a matter of soil enrichment." "Next in importance to hybridisation and proper culture, the interchange and special selection of seed must take a high place." It may be here added that much has been said regarding the value of plants formed by grafting, or by inarching, as for example *C. arabica* on to rooted plants of *C. liberica*. The seeds from such are said to be superior to pure stocks, and in some respects constitute forms nearly as distinct as the crosses and hybrids already mentioned. The *Kew Bulletin* (1898, 30) affords much useful information regarding the hybrid coffees now grown in South India—a subject very greatly developed subsequently by the Indian press. But the industry is much indebted to Mr. W. L. Crawford, Mr. J. W. Hockin, Mr. Brook Mockett and Mr. Graham Anderson—the last-named gentleman having read a paper of great merit before the South Mysore Planters' Association that reviews all the practical results attained.

Stock.

The importance of careful selection of stock cannot, in fact, be overstated, and it is probably not far from correct to affirm that the majority of Indian coffee plantations possess two or more widely different plants treated as if one and the same, the result being irregularity both in quality and yield. The difficulties of the industry preclude any risks being accepted that might be obviated by personal knowledge and care. Hence it is desirable that the nurseries be as near the planter's house as possible, so as to ensure constant supervision, from sowing to picking out and final transplanting. Any departures from the desired type should be instantly removed from the seed-bed, though no opportunity should be lost of studying sports that may appear. Forms directly suited to the climate, soil, and method of treatment pursued in each plantation should be the aim of every planter. But these cannot as a rule be purchased. They must be acquired as local manifestations or crosses specially developed. The study of the seed-bed and the care of the seedlings should be the special charge of the manager himself, not of the overseer or foreman of works. [*Cf.* Lehmann, Lect. in *Planting Opinion*, August 8, 1903.]

Care in Selection.

Planting.

Deep Trenching.

Planting Out.—During the first few years of a plantation it should be dug all over as deeply as possible. After the coffee plants enlarge, thorough and deep trenching becomes more or less impossible without much injury to the roots of the plants. When about a year old the seedlings are planted out into their permanent positions, but if care be taken to select dull weather for this operation, many planters prefer older plants, say two years old. Much difference of opinion prevails as to the distance apart that the plants should be lined in the estate. The question hinges on the following considerations :– (*a*) the nature of the stock selected ; (*b*) the system of cultivation to be pursued, more especially the size of plants desired ; (*c*) the character of the soil ; (*d*) the degree of shade that exists naturally, or that it is contemplated to afford ; and (*e*) the nature of the climate. In cold countries, where the plants are not likely to attain to any great size, close planting may be indicated, the reverse being the case under influences that might be expected to cause vigorous growth. In India the distances apart usually adopted vary from 4 to 8 feet each way, and 7 feet might be said to be common, or 6 feet between the plants and 7 feet between the rows. This would give 1,037 plants to the acre, but in many estates a considerably larger number exists—in some 5 by 5 feet, or 1,740 trees to the acre. On the other hand, Mr. Leeming of Scotforth, in the Shevaroys, was induced some few years ago to believe that a larger plant and more space would give equal, if not better returns, at a much lower cost than the prevalent system of many small plants. He accordingly removed each alternate bush and reduced his estate to 600 plants to the acre. The result was so very promising that he went still further, and reduced it to 300 or 325 plants to the acre. On the average his bushes now stand 12 feet apart each way. In 1899 I had the pleasure of inspecting Scotforth plantation in company with Leeming, as also most of the other coffee estates of that neighbourhood. And I have to admit that Leeming's plants seemed to me in a healthier condition, and to be fruiting more vigorously, than any coffee seen elsewhere. The yield had been greatly increased, the cost of cultivation lessened, the plants rendered better able to throw off disease, and the produce recorded as fetching a higher price than had been the case under former conditions. These are all powerful arguments. But there may be other considerations and conditions that have to be borne in mind. It does not follow, for example, that plants 12 feet apart each way would give everywhere the same results as on the Shevaroys, nor that each race of the coffee plant would do so. The subject is one, however, that is capable of definite verification, and one moreover that it would seem should be solved by every planter for himself. It would not be a very serious matter to place a plot of a few acres under trial, and if the returns proved unsatisfactory the replanting of fresh stock in place of the old and exhausted plants that had been removed would in time repay the outlay.

Distance Apart.

Plants to Acre.

Effect of Thinning.

Cultural Operations.—It is undesirable to give details of the varied opinions and practices that prevail as to the best systems of " holing " and " planting out." The size and depth of the holes depend very largely on the nature of the soil, the lie of the land, and the amount of money and time the planter is prepared to expend. Where money is not a serious consideration, large holes are made, the removed earth being deposited on the higher side, the holes left exposed for some time to the sun and air, then filled in with surface soil, manure and green vegetation (weeds), but with little or none of the earth previously removed. After a time the fresh soil thus furnished will sink, and this depression must

Planting Out.

Temporary Shade.

be made up with fresh surface soil. Farm-yard manure may with advantage be also given until a little mound has been formed, on the top of which the seedling should be planted. Transplanting should if possible be made during cloudy days, and just before the commencement of the most copious season of rain. Temporary shade should be afforded to the seedlings, in the form of small pieces of crude bamboo matting, or simply leafy boughs or tufts of bracken fern. It is also a good plan, especially in exposed situations, to fix a stake to which the stem may be lightly tied. If exceptionally dry weather follow transplanting, it may be necessary to give one or two waterings. In some cases a nursery is dispensed with and two or three seeds are deposited on the specially prepared hole-mounds, the healthiest one being ultimately allowed to grow and the others cut out or transplanted.

Drains.

Improve the Soil

Drainage.—Weeding or removal of wild herbage from the plantation, so as to prevent the young coffee from being choked, now becomes an essential operation. If drains have not been provided at the time the estate was being laid out, by this stage they become imperatively necessary. Nothing is, in fact, more important than a good system of drainage. In the *Pests and Blights of the Tea Plant* (2nd ed., 45-66) it has been urged on the attention of tea planters that the objects of a system of drainage are to increase the depth and improve the condition of the arable soil. Every word of what has been said in that work on the drainage of tea is applicable to coffee. And I may further add that during my inspection of the coffee estates of South India I found few had been drained anything like to the extent practised with tea. I accordingly urged the coffee planters to reform this defect.

Surface Wash.

Pits.

Terracing.

One of the great advantages of drainage is the admission of air (oxygen) into the soil. The drainage of agricultural lands differs thus essentially from that of the streets of a town. The removal of surplus water is undertaken with a definite object in view, the fulfilment of which determines the position and number of the drains. The water is drawn below the surface, and thus made to carry with it the materials that the combined action of the sun and the air have transformed into a soluble condition. To permit or encourage surface wash is to render the soil sterile, in fact to afford facilities for soil-removal. The deeper the drains the further apart they may be placed, and the deeper the resulting arable soil. But drains of some kind are indispensable for successful coffee planting. In many coffee estates that occupy steep, hilly slopes, a system of *trenching* or *contour catch draining* has come into general use, as a protection against severe and wasteful surface wash. The trenches to some extent answer the purpose of refuse pits for the accumulation of manure. In fact in most instances they assume the condition of parallel chains of pits. If used as pits into which the weeds may be thrown, it is customary to have them cleaned out before the setting in of the rains, so as to afford every means of intercepting the fine soil of the surface wash. The contour drains in the tea estates are usually laid out with a level and the earth removed in their formation thrown on the upper side. This is essential, since the slightest slope downhill would convert them into dangerous surface drains. So again *terracing* is an additional method practised with great advantage on some estates, though apt, when exposed to the south or south-west, to dry the soil unduly. But as with contour drains so with terraces, they must be laid out as nearly level as possible.

Bunds.

But when slopes are not too great and the soil fairly light, *bunding* is a third method, superior to even trenching or terracing. Instead of cutting out a terrace, a bank of soil is laid across the slope, and the rain thus made to wash this into a natural wide terrace. In many parts of the country bamboos and prunings are used to form fan-like structures upon which the silting-up process may be encouraged.

Digging.

Digging and Mulching.—Lehmann (*Bull. Dept. Agri. Mysore*, 1902, ii.) has very properly pointed out that coffee is so very different from the majority of the plants cultivated in Europe and America, that it does not of necessity follow that approved Western methods are in every detail applicable to it. "For one thing," he observes, "coffee thrives under the shade of large trees, while in Europe, or at any rate in Canada, the cultivated crops invariably suffer near trees of any sort." He accordingly urges that under the climatic conditions and on the soils that prevail in Mysore, it is essential that knowledge of coffee cultivation should be acquired by direct experiment rather than deduced from general agricultural principles. And in that opinion he is assuredly correct. Coffee is as sensitive, Lehmann tells us, as most plants to the injuries caused by caking or baking of the soil. (Caking the Soil.) In Mysore, he continues, most soils after being dug and then exposed to heavy rain, followed by bright sunshine, become quite as hard on the surface as they were before having been dug. But surely that peculiarity is experienced throughout the world, and on the pure sands of the deserts of Rajputana as much so as on the rich loams of Northern Europe or the coffee lands of Mysore, wherever rainfall is followed by bright sunshine. (Parching.) It is to check the parching and caking action of the sun that gardeners mulch or litter certain crops as a temporary measure. It is with the same object in view that weeding at the commencement of the hot months is discouraged by the cultivators of most tropical countries. (**Mulching.**) Cameron points out that the annual weed "*Blumea*" (*Ageratum conyzoides*) seen in established plantations can do comparatively little harm and that a light covering of weeds might even do good by preventing the surface becoming overheated. To guard against severe caking and overdrying of the soil is a legitimate and rational aspect of all agriculture. (Tillage indispensable.) But to advance from that position to the condemnation of tillage and the rejection of the fully demonstrated fact that the breaking-up of the surface soil and its exposure to the action of heat, light, air and water has the effect of reducing non-soluble to soluble compounds and the production thereby of plant food, seems utterly unwarrantable. The protection of the soil against surface wash and surface caking by a natural litter of leaves (mulching) is very admirable and may be very useful as an occasional process of fallowing, but to expect that any lands, however admirably drained, weeded and mulched, could continue indefinitely to yield coffee or any other crop without tillage or manure, is to carry a natural law to a perilous and unjustifiable extreme. (Influences of Manures.) Lehmann, by his studies of the manures of coffee, has shown that he never contemplated his recommendations for mulching to be the one and only method of treatment of the soil that was desirable. It would indeed be an unwarrantable assumption to affirm that what may be true with a wild plant must be true universally with the same plant under the abnormal demands of cultivation. It is beside the issue to say that mulching has actually been the system with a group of coffee gardens in Coorg for many years (*Madras Weekly Mail*, March 20, 1902). (Soil Exhaustion.) It might fairly be, and in fact has been asked :—"Can it be proved that these very plantations could not have done better during the past?" or, "May they not, even now, be approaching the exhaustion that led to the abandonment of many similar and once fertile estates in that very province?" It is doubtless true that with rich primeval forest land, if well drained and carefully mulched, exhaustion may not become manifest for many years. But it is equally true that with indifferent soils or exhausted lands, mulching can never take the place of tillage and manure.

Advantages of Mulching.

Lehmann concludes his very suggestive report—a most valuable paper even though its main contention may not be accepted as constantly and universally applicable—by the following statement of the advantages of mulching :—"The careful preservation of the natural mulch on pieces on which the coffee has 'closed in' :—(*a*) saves the digging : (*b*) leaves the soil in a better mechanical condition than the usual amount of digging could do : (*c*) probably prolongs the life on an estate and increases its general vigour and productiveness after the first year or two : (*d*) will save a large portion, possibly all the expense of applying bulk manure. Not digging an estate may have the following disadvantages :—(*a*) it is liable to reduce the crop for a year or two : (*b*) it has the tendency to increase the risk of fire."

Deep Digging.

A volume might be written in an attempt to review all the opinions that have been published for and against the tillage of coffee lands. A correspondent, for example, wrote to a Madras paper in 1895 regarding South Coorg—"The change that is worked in a sickly piece of coffee by deep digging is little short of marvellous ; in a couple of weeks' time one would hardly know it for the same piece of coffee." That sentence is fully expressive of the opinions of the vast majority of planters.

Manures.

Chief Kinds.

Farm-yard.

Soil-composition.

Potash.

Manuring and Manures.—Cameron (*Rept. Offic. Visit to Coffee Dist., Coorg*, 1898) has much to say on the necessity for high cultivation and the manures best suited for coffee. He discusses farm-yard manure ; bone ; oilcake ; nitrogenous manures, and the fixation of free nitrogen by the aid of leguminous catch crops ; lime ; phosphates ; potash ; green manures, etc., etc., and commends the use of bracken fern for the litter of cattle on account of its subsequent value as a manure. In his concluding observations he remarks : "The application of proper manure in correct quantity and at the most serviceable time, are things which should be assiduously learned from practical experience." So again, one of the most valuable contributions to our knowledge of the art of manuring coffee is the series of studies conducted by the late Mr. William Pringle, and published in pamphlet form by Messrs. Matheson & Co., of Madras. While we have many similar technical reports, some of which will be briefly mentioned below, very little of a practical nature has transpired of the accumulated experience gained during the seventy odd years of Indian coffee cultivation. The planters prefer, as a rule, farm-yard, or bulk manure, as it is called, and are restricted in its use by the difficulty of procuring enough. Lehmann has recently pointed out that the first and foremost consideration is to see that all the essentials in soil-composition are present, in the right proportion and right condition. Fertilisers may then be given in the direction of crop requirements. He, for example, remarks that "the potash fertilisers have, I fear, not received the attention they require. Judging from the analytical results I have seen, most of your soils are rich in nitrogen but relatively poor in potash, Bone Manures.

Oilcake (*Poonac*).

phosphoric acid and lime, and, although much more potash than phosphoric acid is carried off in your crop, potash is but seldom added." So again, many writers have shown, and most conclusively, that if the soil does not possess enough lime, bone and other expensive manures may be worse than useless. Voelcker (*Improv. Ind. Agri.*, 1893, 270), for example, some years ago observed that the differences of practice occur in the manner of applying manures, some planters preferring to throw manure broadcast and to fork it in, others thinking it better to dig a trench round the bush, about a foot or a foot and a half from the stem, and to put back the soil mixed with whatever manure it is intended to apply. "Manures such as bones, oilcakes, etc., are too generally used, because they have always been used, and because there is a general belief in their utility, but it is more than probable that in some cases large sums are needlessly expended on them, while in others lack of lime, potash, or other soil-constituent may be responsible for a diminishing yield."

Fish.

The manures and the methods of applying them to one plantation are not always applicable to another, so that no general rule can be laid down, and the indications afforded by the soil itself must be closely followed. In some parts of the coffee area, fish manure is much appreciated as a crop fertiliser, cow-dung being viewed as strengthening the wood. Mixed bone and fish manure produce an abnormally heavy crop. Oilcake (poonac) is believed to strengthen the leaves against blight. [*Cf.* Voelcker, *l.c.* 104–5.]

Season for Manures.

Chemical Manures.

The season for applying manure is also a subject of much difference of opinion, but is possibly best solved by a careful study of the particular manure that it is contemplated to be given. Stem and leaf-forming manure should naturally be given just after the crop has been gathered; those supposed to increase the yield would, on the other hand, best be supplied just before the flowers appear, say in February and March. So again, bone and other manures that take some time to decompose require to be given early and soluble manures much later. Many writers seem, however, to condemn immediate or chemical manures and regard these as possessing few, if any, advantages for coffee.

Free Nitrogen.

Leguminous Crops.

Assimilation of Free Nitrogen.—So much has been said of the advantage of growing (as a sort of rotation) leguminous crops along with coffee, that a volume might be written on that topic alone. The subject is by no means new nor confined in its applicability to coffee. A rotation of clover with grain crops became a principle of all early European agriculture, long before the correct explanation of that system had been discovered. Its application to coffee has been urged by all writers, more especially by Mr. B. Nelson. The use of leguminous shade-trees such as the ***sau*** of the Assam tea planters (***Albizzia stipulata***) and the ***Erythrina lithosperma*** of coffee planters are good examples of both shade and nitrogen assimilation. (See below the para. on Shade-trees.) [*Cf. Pests and Blights of the Tea Plant*, 136–47.]

Nitrification of the Soil.

Nitrification.—Allied to the study of free nitrogen, though perfectly distinct, are the methods by which the combined nitrogen of the soil or of manures is prepared for plant use and the processes or vehicles of its transmission into the roots. This is defined as the nitrification of the soil. Nitrogenous matter is oxidised and the nitrogen developed into a nitrate chiefly of lime or of potash. Until quite recently it was believed to be a simple chemical process. But it has been ascertained to be a consequence

Ammonia.

Nitrogen Hunger.

Janse's Discoveries.

of the vital activity of certain organisms, chiefly bacteria. Ammonia compounds are found by the agency of uro-bacteria and other putrefactive organisms before the nitrates are produced. Dr. A. B. Frank (*Lehrb. der Botanik,* 1892, i., 259–75) gives details of some studies of symbiotic fungi found on the roots of certain plants, such as on a few species of *Cupuliferæ* and *Orchidaceæ*. These would seem to aid in nitrification. A long series of articles from the pen of Mr. H. B. Evans will be found in *Planting Opinion* of 1900, in which he advocates that "Nitrogen Hunger" is one of the chief maladies of the coffee plant. He seems to have assumed that the nitrogen of the soil and of the manures of coffee estates does not exist in an assimilable condition. In other words, that the agents of nitrification are absent to a ruinous extent. This, he would further believe, proceeds from the deficiency of a necessary symbiotic fungus, the function of which (Evans affirms) is the transmission of nitrogen from the soil to the roots of the coffee. Should the existence of a symbiotic fungus be actually established for coffee, the conditions that would favour its extended production might become of supreme importance. But the issue, so far as present knowledge goes, is a pure hypothesis. The presence of a fungus on the superficial roots of the coffee was discovered by Janse in Java. [*Cf. Ann. du Jard. Bot. de Buiten.*, xiv., 113–8.] That fungus was most prevalent in soils rich in humus, and was also found on the roots ramifying among the litter of dead leaves on the surface. But no one has as yet proved that Janse's fungus is actually beneficial to the coffee plant, and Janse himself, like all other investigators, failed to specially cultivate it. Although there are possibilities in this direction, the subject is infinitely less known than the action of the bacteria contained in the root tubercles of the leguminous plants indicated above. [*Cf.* Percival, *Agri. Bot.*, 1902, 764–6.]

Too highly manured.

Concluding this brief review of coffee manures, it may be remarked that Voelcker observes very truly that "a sure sign of the land being too highly manured is the appearance of shoots all up the stem. The indication of a good bush is, on the contrary, the healthy growth of new wood on the branches." [*Cf.* Wall, *Manuring of Coffee Estates*; Burgess-Brown, *Coffee Planting* (17 *years' experience in Ceylon*), 1877; Hughes, *Ceylon Coffee Soils and Manures*, 1879; Munro, *Soils and Manures*; Lawes, *Corresp. regarding Coffee Manures*, in *Planting Opinion*, Aug. 1896; Kramer, *Mededeelingen Pl. Java*, 1899, 3, 73; 1900, 64; 1901, 1, 56; Clarke, Prize Essay, *Management of Soils under Coffee*, 1883; Elliot, *l.c.* 350–82; Pringle, *Madras Mail*, 1891; *Revue des Cult. Colon.*, 1901, viii., 198, 294; Lehmann, Lect. before N. Mysore Planters' Assoc. (reprinted in *Planting Opinion*), Nov. 1900; also subsequent lecture in *Planting Opinion*, Aug. 1903; *Cultura Rational du Cafeeiro*, in *Journ. dos Agri. Rio.*, 1902, ii., 57; São Paulo, *Boletin da Agri.*, Jan. 1902.]

Pruning.

Pruning.—Within the past few years, thanks to the enlightened energy of Mr. Leeming of Scotforth, Shevaroys, there has come into existence two diametrically opposite schools. These may be characterised as the non-pruning and the severe-pruning systems. Having studied the latter for some time, and formed the opinion that certain departures were urgently needed, I became a partial convert to the non-pruning system so ably advocated by Leeming. It would seem, at all events, very possibly preferable to the system of severe pruning that presently prevails. Judged of from the purely botanical standard of the state of health and vigour of

Non-pruning.
Severe pruning.

the plants, the non-pruning system seemed superior to the customary form of severe pruning. But I am disposed to add that I can easily conceive of climatic conditions and stock plants where a pruning system would be indispensable, so that I by no means think non-pruning is of universal application. It is, moreover, not new but has for many years been followed in other countries, and even in India has been the practice in vogue with most Native coffee-growers. Leeming would, however, appear to be the first European planter in India who has had the courage of his convictions, and who has not only uprooted two-thirds of the plants on his estate, but allowed those that remained to grow in obedience to soil and atmospheric conditions.

Three Stages.
Topping.

It is customary to speak of coffee-pruning as consisting of three stages, or operations—viz. :—*Topping*, *Handling*, and *Pruning* (proper). The first consists in nipping off the top shoot, so as to check the upward growth. This is done at various stages, usually when the plants are 3 years old, the shoots being then cut at a height of 5 feet; at other times the nipping off is done much earlier, at 18 months to 2 years, the stem being left at from 2 to 3 feet in height. When the short process is pursued, a sucker (as it is called) soon arises near the top pair of branches and renews the upward growth. This is allowed to continue for a foot more and is then in turn nipped off. A second sucker in consequence rises up and is in like manner checked, when the desired ultimate height of the main stem is attained, namely 4 to 6 feet (usually 5).

Snag Formed.
Cleavage of Stem.
Handling.

In the *first* instance (3-year-old stems) there is a terminal snag produced. The topmost pair of branches, below the snag, having the best advantage as to light and air, lengthen horizontally and in due course become so weighted with fruit that the terminal snag of dead wood is split open, and this cleavage increases year after year until many bushes become literally cleft in twain. Admission is thereby given to damp and weather action, also to disease and vermin of all kinds. The aim of the planter in this system of "topping" is to produce a crown or umbrella of primary branches. By what is called "handling," all undesirable suckers and "gormandisers" are systematically removed and every effort made to restrain the bush severely on fixed lines of growth supposed to favour fruiting and be most convenient to the pluckers. [*Cf.* Pierrot, *Cult. Prat. et Ration. du Caféier*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. i., 180-93, 282-301, 411-25, 467-79; v., pt. ii., 34-49, 101-8.]

Interception of Sap Circulation.
Umbrella of Branches.

In the *second* system (largely followed in Coorg), in addition to the terminal snag, with all its possibilities of evil, the growth of the stem is twice checked and snags of dead wood thereby interposed within the stem, which must have the immediate consequence of disarranging and intercepting the circulation of the sap. Nothing could be conceived less advantageous. Moreover, the effort is made by the growth of the secondary branches, ultimately produced, to convert the topmost three or four pairs of primaries into a completely ramified umbrella, that must of necessity render the branches below a useless burden on the resources of the plant. M. Edouard Pierrot recommends a system of pruning that does not seem to me to differ from that followed by the Indian planters. His account of coffee-planting is, however, most instructive, and should be consulted by all interested in the industry.

Reform Imperative.

So far as could be learned from personal observation, few subjects are perhaps more urgently calling for reformation, both as an aid against

Vertical *versus* Horizontal.

disease and as a means of enhancing returns, than the system of pruning. Any pruning seemed accordingly preferable to that usually practised. By encouraging a vertical rather than a horizontal growth, the fruiting area of the estate is (if one may so express it) immensely increased. But where, from the nature of the soil, the peculiarities of the climate or the character of stock grown, "coffee trees" could not usually be produced (such as those of Scotforth), it would seem that a pyramidal bush might nevertheless, and with advantage, be aimed at rather than a fruiting umbrella. This might be accomplished in various ways that doubtless would instantly occur to the practical planter.

Suggested Method.

Without desiring to dictate, one method that suggested itself to me while inspecting the coffee estates of the Wynaad may be here mentioned. Plants 4 feet in height, or when they possess 6 or 7 pairs of branches, might be taken in hand. In some plantations, however, bushes only 2½ to 3 years old were seen to possess 15 to 20 horizontal branches, within a height of 4 feet. It is very unlikely that these could all bear fruit, hence perhaps half may have to be removed. But when the approved number of primaries had been secured, the *green terminal shoot*, containing a pair of leaves and a bud, might be nipped off, and at the same time the terminal buds of the topmost three or four primaries similarly destroyed. Care would have to be taken, however, that this plucking off of the terminal buds was done on green not woody shoots. Delay till wood is formed almost invariably involves a snag, and moreover the cutting back of finally matured shoots requires great care and a study of the best age and most favourable season for each locality. The object aimed at by the system suggested would be the production of a pyramidal bush, and if sufficient space were allowed such might ultimately be expected to fruit from the ground to the topmost twig. The check given to the growth of the upper primaries would prevent their attaining the size and weight sufficient to split the stem (in the way already mentioned). The secondaries borne by each primary would in time become fan-shaped, and through the regulation of the lengths of these fans the bush would become completely pyramidal. It is the secondaries borne on the primaries that are the fruiting shoots, and the purpose of the recommendation here offered would be to produce a maximum of such, fully exposed to light and air. Similarly a vertical pyramidal bush might be formed by the development of upward-growing suckers in place of horizontal branches, the main branches being trained to ascend from the stem or its primaries, like those of a poplar. But I need not enlarge on this theme. What seems imperatively necessary is greater spacing, a better-shaped and a more healthy bush. Mr. Leeming's "coffee trees" in these respects, at all events, are as nearly perfect as seems likely to be attained; and where trees are not possible, bushes of a tree shape might be secured in preference to that of an umbrella. (See the remarks above on the tendencies of certain races to produce ascending and of others spreading branches.)

Season of Pruning.

To conclude these observations, it may be said that pruning as presently practised is done about March after the crop has been collected, and consists in removing all shoots that have borne fruit and in selecting and protecting those that are intended for next year's crop. But the pruning must be completed before the flowers begin to form, and in pruning it is often recommended to leave alternately the opposite laterals. All tertiaries, as also diseased branches, are usually cut off. A *handling* is often given just after the flowers appear, in order to remove useless flushing. During a second *handling* suckers and crosswise shoots are rubbed off, without injuring the bark, and, in carefully worked estates, even a third handling is often given. It seems to be an accepted rule that September and October shoots should be preserved, and that as many of those formed in February as can be spared should be removed; but during fruiting the plants are never interfered with. In many estates removal of moss and cleaning the bark is regarded as of great service to the plant and obviates the harbourage of pests and blights.

Second and Third Handlings.

Shade-trees.

Shade-trees.—When Arabian coffee is grown upon lands of low altitude, shade becomes imperatively necessary, but in these positions Liberian may be successfully grown without any shade. As the upper limits of Arabian coffee cultivation are reached, shade may be largely dispensed with. Much difference of opinion prevails as to the extent and nature of the shade best suited to each region. Cameron (*Rept. Tours in Coorg*, 1898) very properly urges that a mixture of different shade-trees is preferable to one particular tree all over an estate. The balance of soil is thereby secured and a better shade attained. In Mysore tall original trees are generally preferred to the leafy bushes specially resorted to in other localities such as the Shevaroys. If protection from wind be the object aimed at, shelter belts of strong densely branched trees are indicated, but if shade from the sun be the object, much will depend on the severity of the sun and the liability to borer. It is the accepted belief that shade gives a certain protection from that pest, and this circumstance, more than protection from the sun, often determines the nature and extent of the shade-trees desirable. As little shade as possible is necessary during the rainy months, and the maximum shade during the hotter months. The study of the season of new leaf in shade-trees is, therefore, all-important.

Dal.

Dal (***Cajanus indicus***) would make an excellent shade-bush for young coffee, and by its root tubercles and copious supply of leaves it would enrich the soil at the same time, but its liability to fungal disease (see p. 198) might be viewed as rendering it undesirable. Another Leguminous plant has been much appreciated by coffee planters—viz. one or other of the species of ***Erythrina*** such as ***indica***, ***lithosperma*** and ***suberosa***. Mr. B. Nelson (*Planting Opinion*, 1896 to 1899) wrote a series of articles and showed that the use of ***E. lithosperma*** as a shade-tree gave a material increase to the yield of coffee. The Silver Oak (***Grevillea***) is much commended by many planters, but while useful for shade it can have no manurial value. The other trees, fairly extensively employed, may be here mentioned in alphabetical sequence, viz. :—***Acrocarpus fraxinifolius*** ; ***Albizzia Lebbek***, ***moluccana***, ***procera*** and ***stipulata*** ; ***Artocarpus Chaplasha***, ***integrifolia*** and ***Lakoocha*** ; ***Bischofia javanica*** ; ***Cedrela Toona*** ; ***Dalbergia latifolia*** ; ***Ficus asperrima***, ***glomerata***, ***hispida***, ***infectoria***, and ***mysorensis*** ; ***Grevillea robusta*** ; ***Pithecolobium Saman*** ; ***Pterocarpus Marsupium*** ; and ***Trema orientalis***. Many other trees might also be mentioned, such as one or two exotic plants, for example India-rubber (***Manihot Glaziovii***) and ***Eucalyptus***. As catch crops Indian corn has also been tried, and with fair success ; and in Coorg, pepper and cardamoms are much resorted to, especially by Native cultivators. [*Cf. Kew Bull.*, 1895, 306 ; Graham Anderson, *For. Trees in Coffee Lands Mysore*, 1888 ; *Rept. Agri. Chem. Mysore*, 1901–2, 29–35 ; *Journ. d'Agri. Trop.*, 1902, ii. 124–5 ; *Trop. Agrist.* ; *Planter* ; *Madras Mail*, etc.]

Erythrina.

Silver Oak.

India-rubber.

Pests and Blights.

ENEMIES—PESTS AND BLIGHTS.—To give even the most general outline of this subject would occupy many pages. Having studied with some care the enemies of the tea plant, the first impression left on my mind, on visiting the coffee plantations, was the comparative absence of pests. An ordinary tea garden when compared with a coffee plantation would afford the entomologist ten to every one for his special study. Even the blights or fungal diseases are far less numerous, though one is very much more prevalent and widespread than any of the blights of tea. At the lowest possible estimate there are 200 insect pests on the Indian tea plant, and perhaps not twenty all told on the coffee. But the few that are present are often disastrous to the industry, and thus make up for their specific paucity by their individual voracity. In fact it may be said that two or three insect pests and one or two fungal blights have practically baffled both planter and scientist and have proved so disastrous as to have ruined the industry over large tracts of country. This is significantly true of Ceylon, the leaf-blight having there proved so completely incurable as to have caused the planters to substitute tea for coffee, as their only escape from ruin. Numerous reports and monographs have been published by Morris, Marshall Ward, Nietner, Bidie, Harman, Cooke, Massee, Barber, etc., so that it cannot be said the subject has been neglected, but so far little progress has been made of a practical nature.

The more important diseases of the coffee plant are the following :—

Leaf-blight.

1. ***Leaf Blight, Hemileia vastatrix,*** *Berk. & Broome, Gard. Chron.*, Nov. 6, 1869, 1157; Abbay, *Journ. Linn. Soc.*, 1878, xvii., 173-84; Morris, *Coffee Leaf Diseases Ceylon and S. Ind.*, 1879; Harman, *Coffee-Leaf Disease Bangalore*, 1880; Jardin, *Le Caféir*, 1895, 264-6; Tubeuf, *Plant Diseases*, 1897, 352; Philip MacMahon, *Queensland Agri. Journ.*, April 1898, ii., 301; Massee, *Textbook Pl. Diseases*, 1899, 27, 231–2, 407; Lecomte, *Le Café*, 193-203; Jumelle, *Les Cult. Colon.*, 376–7; Massee, *Rev. Genus Hemileia*, in *Kew Bull.*, 1906, 35–42. This fungal disease appears to have been first observed on coffee in Ceylon, about the year 1869, and in South India two years later. It has since appeared in

Distribution.

Burma, China, Java, Sumatra, the Philippine Islands, and been identified as met with in the coffee districts of Africa (even at Victoria Nyanza), and probably wherever coffee is cultivated in the Old World.

Origin.

It has been assumed as probable that ***H. canthii***—a parasite found on ***Canthium campanulatum***—was the parent source of ***H. vastatrix***, the differences observable between the two fungi being in all probability the result of growing on slightly different hosts. So in the same way leaf-blight, seen in Natal and other African plantations, may have originated from ***H. Woodii***—a parasite found on two species of ***Vangueria*** and even on ***Coffea Ibo.*** Massee accordingly writes: "It is not at all necessary to assume that the coffee disease has been imported along with the coffee plant from one country to another, taking into consideration the wide distribution of different species of plants attacked by ***Hemileia, vastatrix*** or ***H. Woodii***, both of which are capable of infecting species of ***Coffea.***" In India there are some six or seven species of ***Canthium***, fairly abundant wild plants in the coffee area, also a species of

Practical Lesson.

Vangueria both in Kanara and the coffee tracts of Burma. If, therefore (as pointed out by Massee), a practical lesson is to be drawn from these considerations, to start a plantation in a district where these and other allied plants to the coffee are abundant would probably mean disaster. To grow for the purpose of shade, plants belonging to that family would also very possibly be dangerous. All rubiaceous plants should therefore be watched for any appearance of leaf-blight, and exterminated as far as possible from proximity to coffee.

The leaves of coffee are the parts most frequently attacked by ***Hemileia***, though spots are sometimes present on the young shoots as well as on the fruit. These expand in size irregularly, are at first pale yellow, but in time become bright yellow and orange coloured. Though showing through on both surfaces, the spores appear on the under-surface only. These are formed in dense clusters, and emerge from the tissue by the breathing mouths (*stomata*) of the leaves.

Treatment.

While touring through the coffee districts of South India I observed the grub of a minute insect feeding on the spores of this fungus. I was told this had been seen by the planters for some years. It would appear of importance that the life history of that little creature should be worked out, since it may be the planters' greatest friend. When leaf disease is at all serious it is so prevalent as to render most of the methods of treatment, that have as yet been suggested, quite impracticable. Syringing with fungicides, such as the Bordeaux mixture, sulphuring the leaves, removing and burning the leaves, tearing off or punching out the diseased portions, have each and all been advocated and tried with varying, though never with complete, success. The best results as yet recorded liability to borer may be increased, but leaf-blight brought under control. On some soils, under certain climates, or with particular exposures, leaf-blight never has been serious, and, moreover, either the plants are now better able to withstand the disease or its virulency is being attenuated, because in South India coffee-planting is by no means impossible, in spite of blight and borer. The low prices, through overproduction in South America, are far more serious than all the blights at present known. There would seem little doubt that had the Ceylon planters cultivated and manured their estates more thoroughly and systematically than they did their industry might have been saved. When the disease appeared both soil and plant were exhausted. The rapidity of the destruction that ensued may be thus demonstrated: average yield for the years 1866–8, all over the island (that is, before *Hemileia* appeared), was 4·28 cwt. per acre; in 1872–4 it had fallen to 2·93 cwt. per acre, and in 1878 to 2 cwt. per acre.

Ruin of Ceylon Plantations.

2. ***American Coffee Disease, Stilbum flavidum, Cooke;*** Massee, *l.c.* 445; Lecomte, *l.c.* 204; Jumelle, *l.c.* 377.

"This disease is almost as destructive to the coffee industry in the New World as *Hemileia vastatrix* is in the Old World." "The symptoms of the disease are unmistakable; circular whitish blotches occur on the leaves, often in considerable numbers, and are equally marked on both surfaces. Using a pocket-lens, very minute fungi resembling a miniature pin in shape, and of a clear yellow colour, can be seen grouped on the spots on the upper surface of the leaf. The berries are also sometimes attacked, being marked with circular spots. On the young shoots the pale diseased spots are elongated" (Massee). As this disease has not appeared, so far as is known, on the coffee of Asia, we have the somewhat significant fact of two coffee blights, the one confined to the Old and the other to the New World. A species of *Stilbum* does considerable injury to the tea, being the Thread Blight of tea planters. [*Cf. Pests and Blights of Tea*, 392.]

Leaf-rot.

3. ***Leaf-rot.***—This leaf-blight was described by Cooke under the name *Pellicularia koleroga*, the specific name being the vernacular for the disease. [*Cf.* also Tubeuf, *l.c.* 518; Lecomte, *l.c.* 203.] It is said to be prevalent in Mysore during July; the leaves, flowers and berries become covered with a shiny gelatinous substance which turns black about the time that the affected parts fall from the plant.

Cameron thinks that continuous or heavy rainfall, dense shade, drip, and stagnation of drains favour the development of this blight. Improvements to combat these defects are beneficial. All affected leaves should be burned or dusted with flowers of sulphur. As seen in the Kew Herbarium the leaves are covered with a simple mycelium much as in *Stilbum*, but without any fructifications. Samples of it have come from the coffee plantations in Venezuela, Costa Rica and Jamaica, as well as Mysore, so that it is fairly widespread and should it commence to assume its complete form, may become a serious pest. It should therefore be kept under control and carefully studied.

Twig Disease.

4. ***Coffee-twig Disease, Necator decretus, Massee,*** *l.c.* 327. This Twig Disease is said to be a destructive parasite on coffee trees at Selangor. It commences at the tips of the young branches and extends downwards. Bursting through the epidermis of the shoots are minute white spots, which soon become orange-red in colour and gelatinous in texture. The twigs thereafter turn black and thus appear as if syringed with acid, while at the same time the bark splits as in canker.

Withered and Blackened Berries.

During my tour through Coorg and the Wynaad I was shown a disease that brings to mind the Malay twig disease or canker just described. The tips of the fruiting shoots, including a large number of leaves and berries, become withered and dried up, and in due course turn black. I was unable to discover on these any fungus, but obviously should have visited the plantations at a much earlier season of the year in order to study the distressing disease indicated. The withered fruits, if gathered along with the ripe cherries, greatly lower the value of the crop, so that they are not only a serious loss but a source of danger through their being inadvertently collected. The Indian planters regard the blackened and withered shoots as a consequence of a want of general tone and vigour, and as proceeding from poverty of soil rather than being due to any specific disease. An inspection of the specimens preserved at Kew leads me, however, to suspect that it is due either to the self-same species, or an allied fungus to that just described as the coffee-twig disease of Selangor.

Borer.

5. ***Borer;*** *Ind. Mus. Notes*, ii., 153. This pest used to be known as "Worm" or "Coffee Fly." It is most troublesome in Mysore, South Coorg and the Wynaad, where in 1865–6 it destroyed whole estates. It has also appeared in the small coffee gardens of Assam and Burma. It is the grub of a beetle, ***Xylotrechus quadrupes,*** *Chevr.*, and is yellowish-red with black transverse lines. It damages the tree by boring holes into the stem, usually a few inches from the ground. These passages are at first transverse, but soon ascend spirally to the growing tip, where the larvæ are matured. The plant early shows signs of death and ultimately withers down to the point where the beetle entered.

Nim Oil.

This pest is most prevalent in hot, exposed gardens, and may be kept in check by free irrigation, good tillage and the growth of large shade-trees. Cameron speaks of *ním* oil, poured into the openings made by the borer, as being useful in either expelling or killing the grub. As a preventative it is believed also desirable to encourage rather than interfere with the nesting of insectivorous birds in the plantation. If the stems of injured trees are collar pruned, new suckers are thrown out and the plants thus renewed, while the borers with the channelled stems are destroyed.

Another borer is the larvæ of the moth ***Zeuzera coffeæ,*** *Nietner.* [*Cf. Ind. Mus. Notes*, ii., 157; Watt and Mann, *Pests and Blights of Tea*, 200–1.]

Bugs.

6. ***Bugs.***—Various insects are by planters all called bugs. They belong for the most part to the family known as the COCCIDÆ or Scale Insects. There are four chief pests of this kind, known as Brown, Green, Black and White Bug.

Brown Bug.

The Brown Bug, Lecanium hemisphæricum, *Targ.*; Green, *Coccidæ of Ceylon*, 232–4, pl. 85; *Ind. Mus. Notes*, ii., 168. "This insect was formerly known as the 'Brown Bug' of the coffee plant, and before the advent of the 'Green Bug' was considered the most serious insect pest of that plant." "For some years before the coffee failed, the bug—as a pest— had practically disappeared." It is met with now and again all over the coffee area of India, but nowhere to a very serious extent. It is perhaps most harmful in the Shevaroy, Nilgiri and Mysore plantations. [*Cf. Agri. Journ. Ind.*, 1906, i., pt. i., 77–8.]

Green Bug.

The Green Bug, L. viride, *Green*; *l.c.* 199–203, pl. 69; *Ind. Mus. Notes*, ii., 168. This proved such a scourge in Ceylon that it was practically responsible for the final abandonment of coffee cultivation over the greater part of the planting districts. It first attracted attention in 1882, and by 1886 had been dispersed all over the coffee districts of Ceylon. It attacks weakly trees and almost completely denudes them of all but the two or three terminal leaves. On healthy plants the leaves become black through the attendant fungus, but do not fall off, and the bushes make a vigorous effort to grow. In Ceylon the plants had been weakened by ***Hemileia*** when they became infested with green bug. In 1881 the exports were 452,000 cwt., but ten years later they had fallen to 88,780 cwt., and in 1902 were only 10,000 cwt. [*Cf. Agri. Journ. Ind.*, 1906, i., pt. i., 78.]

Black Bug.

The Black Bug, L. nigrum, *Nietner*; Green, *l.c.* 229–31, pl. 84; *Ind. Mus. Notes*, ii., 168. This bug, though found on coffee, is not so serious a pest as either the brown or green bug.

Mealy Bug.

The White or Mealy Bug, Pseudococcus adonidum, *Linn.*; *Ind. Mus. Notes*, ii., 168. This is a flat oval creature covered with white down arranged in parallel ridges and running across its back. It prefers hot, dry plantations and would seem to be harboured by the species of ***Erythrina*** now so largely grown for shade purposes. In a plantation in the Wynaad where the trees had been cut down, I observed white bug very prevalent on the underground portions of the stems, as also on the roots, and swarming to the neighbouring coffee. Whether or not this observation is of invariable application cannot at present be affirmed, but plants seen to favour the growth of any species of bug should be discouraged in coffee plantations even although the present species has not been recorded as doing serious damage.

Treatment.

Every effort has been made to exterminate these pests. But in the case of green bug, the insect, being green in colour and small in size, was not noticed until it had been established in Ceylon in such force as to defy all subsequent efforts at extermination. It usually decreases during both very wet and very dry weather. The most hopeful method of dealing with it, as also with all other scale insects, is through their natural enemies. The larvæ of certain ladybird beetles (***Chilocerus circumdatus*** for brown bug, and ***Scymnus rotundatus*** for white bug) live on them, and a minute chalcid wasp breeds within the body of the mature ***Lecanium***. So also a parasite fungus (***Cephalosporium lecanii***) kills these insects by living on their bodies.

Grub.

7. ***Grub.***—The larvæ of the moth ***Agrotis ypsilon***, *Rott.*; *Ind. Mus. Notes*, ii., 161; iii., 21; Watt and Mann, *Pests and Blights of the Tea Plant*, 1903, 220–3; Maxwell-Lefroy, *Memoirs, Dept. Agri. Ind.*, 1907, i., 169. The Cutworm, Black Grub or Ringer are very destructive to the seedlings of coffee, as much as 25 per cent. being often found destroyed by this pest. It seems to have been specially destructive in Mysore

The larvæ of the cockchafer, ***Lachnosterna pinguis***, *Walk.*, often do much damage by eating the roots of the young coffee plants. [*Cf. Ind. Mus. Notes*, ii., 149; Watt and Mann, *l.c.* 167–9.]

8. ***Other Insects*** that occasionally attack the coffee may be here enumerated:—***Arhines destructor***, *Nietner*, a weevil that eats the leaves ***Parasa lepida***, *Cramer*, a moth that defoliates the bushes; ***Narosa conspersa***, *Walker*; ***Aloa lactinea***, *Cramer*; ***Euproctis virguncula***, *Walk.*; ***Trichia exigua***, *Feld.*; ***Galleriomorpha lichenoides***, *Feld.*; ***Epithecia coffearia***, *Feld.*; ***Boarmia leucostigmaria***, *Feld.*, and ***B. zeylanicaria***, *Feld.*; ***Tortrix coffearia***, *Feld.*; ***Capua coffearia***, *Nietner* [*cf. Ind. Mus. Notes*, v., 187], and ***Gracilaria coffeifoliella***, *Motsch.* (recalling ***Elachista coffella***, *G.M.*, in Jardin, *l.c.* 258–9 and pl.), are all moths reported to have been occasionally met with on coffee in Ceylon. So also ***Anthomyza coffeæ***, *Nietner*, is the coffee-leaf borer; ***Stachia geometrica***, *Motsch.*, a species of ***Rhynchota*** that attacks the coffee-cherries; ***Aphis coffeæ***, *Nietner*, the coffee-louse (parasitised by ***Micromus australis***); and ***Acarus coffeæ***, *Nietner*, the coffee-mite. So far as presently known, none of these pests have given any cause for anxiety to the Indian planters.

9. ***Other Pests.***—Locusts, Weevils, Rats, Squirrels, Monkeys and Jackals often do much injury—the animals mentioned being very fond of the ripe cherries.

Life of the Estate.—The late Mr. William Pringle very rightly observed that "no matter how healthy a coffee tree may be, no matter how carefully pruned, handled, tended and nourished, its life will end sooner or later. Under favourable conditions, the tree may live for fifty or sixty years; as a rule, it will seldom last thirty. It will, under favourable conditions, be in full bearing in the fifth or sixth year, and may go on for twenty to twenty-five years giving paying crops. Many trees are exhausted in ten to fifteen years by unskilful treatment, borer, and attacks of ***Hemileia vastatrix***, etc., and must make room for a new generation. If the vacancies can be successfully supplied and the plants developed in a healthy and vigorous manner, there is no reason why an estate should be limited as to age. If we can so arrange matters as to have a continual succession of young plants coming on and developing into healthy trees to replace those taken out, a coffee estate may be considered as a permanent investment. In suitable localities efficiently drained and manured this can be done: and an estate may be considered to be working under the best possible conditions of perpetuation where from 4 to 5 per cent. of vacancies occur every year that are successfully supplied. It is upon the success of the supplying that the life of the estate depends, and practical planters consider this question one of the first importance in Southern India. It is only when supplies cannot be got to grow that there is a necessity to abandon the estate. With many aspects and under some conditions the plants cannot be raised, except at a ruinous cost."

Age of Coffee Plants.

Permanent Investment.

MANUFACTURE.

Berries.
Pea-berry.
Pulp.
Parchment.
Silver-skin.

Terms Employed.—The ripe coffee fruit is called the "Cherry"; the contained twin seeds are the "Berries." When only one seed is developed it is spoken of as "Pea-berry." This is often upheld to be richer in flavour, and accordingly much has been said about the possibility of producing a plant that would yield mainly, if not entirely, pea-berries. The succulent outer coat of the fruit is the "Pulp," and the inner adhesive layer is known as the "Parchment." The seed-coat within the parchment which adheres closely to the seed is called the "Silver-skin." The pulp is commonly removed at the plantation, but it is frequently the case that the berries are sold in parchment and either submitted to treatment in the coast towns or exported in that condition to Europe, where they are hulled and finally prepared for the market. The machinery for this purpose is expensive, and the operation of final cleaning can be as effectually if not better accomplished in Europe than at the plantation. It is believed moreover that the coffee carries best in parchment, so that the extra freight charges are more than compensated for by the quality of the coffee turned out in Europe. [*Cf. Kew Bull.*, 1893, 128–33.]

Cherry.

The preparation of the berry from the cherry is effected by certain distinct operations that may be here indicated very briefly. It would, however, be impossible to describe all the methods and appliances used without devoting many pages to this subject.

Seasons.
Rain.
Colour of Cherries.
Greenish Tint.
Jackal Coffee.

Seasons and Crops.—The blossoms as a rule appear in March and the fruits commence to ripen in October and continue till January. The more gradually the blossom fades the better: a superabundance of flowers is not considered a good prognostication, since only a small percentage form fruits. Rain during flowering is unfavourable, but after the fruit has set a shower or two is beneficial. It is usually advocated that none but fully ripe fruits should be collected. In Arabia a cloth is placed below and the bushes shaken, when the ripe cherries fall into the cloth. In India they are hand-picked, and it is believed not necessary that they should be pink-coloured all round; the slightest tinge is sufficient, and in fact with the appearance of colour the sooner picked the better. The berry (seed) inside will be found to be of a fine dark-greenish or bluish-green colour. It is the endeavour of the planters to preserve this greenish tint as much as possible. Berries that have dried into a reddish or chocolate colour are spoken of as "foxy," and the presence of such lowers very greatly the price. Berries that have fallen to the ground are collected at the end of the season and are known as "Jackal Coffee."

Pulping.
Machinery.
Disc-pulper.

Pulping.—The operation known by this name is the removal of the pulp which surrounds the "berries" (seeds). This is best done day by day on the collections being brought to the factory. If unavoidably delayed it may be necessary to produce fermentation before the cherries can be pulped. There are two chief forms of the pulper, viz. the disc or the cylinder, but a long list of special machines, mostly developments of these, might be given. The principle in both is a grater, working against a smooth chop, adjusted according to the size of cherries. The disc-pulper is the simplest contrivance, and this may be either single or double and worked by hand or steam. A single pulper will accomplish 20 to 25 bushels an hour, a double one 40 bushels, or twice that amount if driven by steam. In design it is somewhat like a cotton-gin: it tears off the pulp and drops the seeds through a sieve kept in position so as to carry forward the pulp or tails. The best design for a factory is a three-storied building placed against the hillside and so arranged that the cherries are conveyed to the top story without requiring a lift. From there a hopper carries the cherries and water, in a continuous stream, on to the grater. Space cannot be afforded to discuss the other numerous inventions that exist for pulping; suffice it to say that most Indian factories are behind the standard of those in other countries, and that the defects of much of the Indian coffee are due mainly to the imperfections of the factory.

Tails.

Factory.

Indian behind Date.

Native coffee is mostly dried with the pulp attached, then pounded in a mortar. It is thus practically the system followed in Arabia in ancient times, and which is still to some extent pursued in that country.

Fermentation and Washing.—On the beans (seeds or berries) passing through the sieve they are found to be covered with a sticky mucilaginous material. If the contained saccharine matter be not removed it is difficult to dry the berries. This is accomplished either by washing or fermenting, or more generally by both. The period necessary for fermentation depends greatly on the temperature of the atmosphere, but from 12 to 18 hours usually suffice. Mr. Graham Anderson has shown that the amount of saccharine matter depends on the exposure, and that the produce of young trees will not ferment as readily as that of mature plants. The berries, after thorough washing, are spread out to dry on specially prepared platforms which constitute the lowermost portions of the factory.

Washing.

Fermentation.

Saccharine Matter.

Hulling or Milling.—This consists of the removal of the parchment and silver skin from the beans. As already stated, this operation is usually performed by the traders and not by the planters. Many firms, especially at the coast towns, do the milling, such as Staines & Co. of Coimbatore, but a large proportion of Indian coffee is milled in London. The Indian planters seem to be of opinion that this operation might be much improved by better machinery than exists in India. [*Cf. Planting Opinion*, Aug. 1899.] A bushel of parchment coffee will usually give half the quantity of clean beans. The coffee is then assorted into various grades according to size of berries. This not only meets the necessities of various markets, but has the effect of furnishing a uniform berry and one that will roast to the same extent throughout. Nothing injures coffee more than a percentage of small berries that become charred before the others are sufficiently roasted. Charcoal absorbs completely the aroma of coffee, hence charred berries are positively destructive of merit.

Hulling.

Yield.

Assortment.

Size.

Packing.—It is of the greatest consequence also that attention be given to the art of packing. If berries be exposed to the drying action of the atmosphere beyond a certain extent, their value may be thereby greatly depreciated. All the best coffee is accordingly packed in casks, the utmost care being taken that the wood used may not taint the coffee. Packing in sacks or bags is much inferior, and if shipped with mixed cargoes, coffee in bag may be so tainted as to be next to useless.

Packing.

Drying.

Casks.

Sacks.

Adulteration and Substitutes.—This subject has attracted much attention for many years. It may be confidently affirmed that although much difference exists between the coffee of one estate and another, dependent very largely on the process of manufacture and the care bestowed in drying, assorting and packing, direct adulteration never takes place at the plantation. While that is so, there is perhaps no other dietary article so much and so persistently adulterated as coffee. This is very largely a consequence of the legislative measures that prevail in the countries of

Adulteration.

Never done at the Plantation.

Caused by High Taxation.

Mixing.

Chicory.

consumption. When taxed abnormally high, adulteration prevails. But this is often safeguarded by special legislation such as the French enactments that prohibit the vendor from mixing. In England, on the other hand, mixing is so much in vogue that it is often difficult to procure pure coffee. "Our Coffee Mixture" may contain any adulteration conceivable, with perhaps not more than 5 per cent. of coffee. This is the natural consequence of legalising mixtures. Criminality consists alone in selling as "pure coffee" an article that contains anything but coffee. Legally "Chicory" may be the roasted chicory root itself, or the root of an allied plant or other vegetable substance applied for the same purpose.

Adulterants.

Examination.

The substances mostly employed in adulteration of coffee are the roots of chicory, dandelion, mangold-wurzel, turnips, parsnips, and carrots. The seeds of beans, peas, date-stones, malt rye, burnt sugar, biscuits, locust-beans, figs, etc., are all used. Roasted flour coloured with ferruginous earth and flavoured with the grounds of exhausted coffee or of other even more objectionable substances are often sold as coffee. There seems every reason for believing that the decline of the demand for coffee throughout the world is largely a consequence of the difficulty in obtaining the pure article. For further particulars regarding coffee adulteration confer *Chicory and Coffee*, a lithographed report by J. D. Hooker, John Lindley, Thomas Graham, John Stenhouse, Dugald Campbell, William B. Carpenter and A. S. Taylor, issued by the Inland Revenue office in 1853. This gives the microscopic structure and chemical tests by which the adulterants of coffee may be recognised, and although more recent publications exist on this subject, hardly any are more accurate and authoritative. [*Cf. Food Journal*, March 1870, Dec. 1873; Clifford, *Journ. Soc. Arts*; and Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 271–4.]

Negro Coffee.

The seeds of several species of ***Cassia*** are used as coffee substitutes under the name of Negro Coffee. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.*, 1900-1, 23-4.] For "Malt Coffee," consult Hanausek (*l.c.* 354).

TRADE IN INDIAN COFFEE.

Standards.

Caffeine.

Percentage.

Specific Gravity of Berries.

Colour.

Odour.

Commercial Tests.—The value of coffee depends upon many circumstances, such as form of the berry, its size, colour, smell, flavour, age, and uniformity. One of the greatest difficulties is to discover a standard by which merit may be definitely determined. Were it possible to fix a standard, the planters could aim at a definite article. Much has been done in India by Mr. Leeming, Dr. Lehmann and others in this direction, and it is believed their efforts may soon be rewarded. Lehmann found that the quantity of the alkaloid CAFFEINE was no evidence of quality. Caffeine (as shown by M. Bertrand) varies greatly. In ***Coffea arabica*** it ranges from 0·83 to 1·60 per cent.; in ***C. liberica*** between 1·06 and 1·45 per cent.; and in ***C. stenophylla*** between 1·52 and 1·70 per cent. In a series of specimens specially analysed, those that had the highest specific gravity and contained the most nitrogen and phosphoric acid brought the highest price. Colour seems to depend more on the degree of ripeness when collected, and the care taken in manufacture, than on the nature of the soil or the class of plant grown. As a general rule the Old World coffees are inclined to turn yellow, and the New World green. Weight decreases with age and by overdrying. Odour is perhaps the most important criterion, and apparently it can alone be determined by expert opinion.

Yield.

Yield and Cost of Production and Price Realised.—Under the paragraph devoted above to "Localities and Area" will be found all the

3 to 7 Cwt.

¼ to 1 Cwt.

Cost.

particulars on these topics for which space can be afforded in this work. The regions of Indian cultivation, the average production, and the estimates of yield per acre have thus been exhibited. These facts have to be re-read in connection with the returns of trade that have presently to be furnished. It has been shown that an average of 3 rising to 7 cwt. an acre would fairly express the better-class European plantations, but there is a large number of small Native concerns that lower both the average yield and the quality of Indian coffee. It is believed that the Native plantations yield from ¼ to 1 cwt. an acre. The cost of cultivation has been variously put, but it seems probable that Rs. 120 per acre for the best European and Rs. 40 for Native coffee would be safe estimates. The former would include manuring, as also all factory charges. It is generally stated that the lowest cost of production on European plantations is Rs. 80 yielding 2½ to 3 cwt. an acre.

Wages.

Labour to Acreage.

Decline.

The net cost of coffee has been taken as Rs. 27 a cwt., and since the cost of production is 60 to 70 per cent. wages paid, a fair computation of the value of the industry to the inhabitants of the coffee area may be arrived at by multiplying the European and Native acreage by the estimated cost of production. The mean of all the figures usually published shows one person to be employed on every 2½ acres of coffee. But such calculations are tentative in value only, as there is perhaps no other Indian industry more obscure and misleading, so far as its statistics are concerned, than that of coffee-planting. There are, however, three fairly certain aspects, viz. that the cultivation (see p. 370), production and price have all three seriously declined within recent years. Thus taking the price obtained in 1874 as being 100, we have the following relative prices for Indian coffee down to 1902 :—

Prices.

YEAR.	PRICE P.C.		VARIATION.	YEAR.	PRICE P.C.		VARIATION.
	s.	*d.*			*s.*	*d.*	
1877	110	0½	120	1894	101	0	110
1879	100	10	110	1897	94	8	103
1882	85	4	93	1898	78	1	85
1884	76	4½	83	1899	65	2½	71
1887	94	9½	103	1900	47	0	51
1889	99	10	108	1901	47	3½	51
1890	106	2½	115	1902	60	1½	65
1893	105	4½	114				

During the past five years the actual prices realised were:—1901–2, Rs. 49–0–4 (variation 65); 1902–3, Rs. 49–1–5 (65); 1903–4, Rs. 46–15–2 (62); 1904–5, Rs. 50–6–2 (67); 1905–6, Rs. 48–12–4 (65); 1906–7, Rs. 43–11 (58) per cwt. As with estimates of average yield, so with prices: the average may be quite misleading as a factor of possible results. But, as already observed, competition with the cheap production of Brazil has proved the most alarming feature of the Indian industry.

Competition with Cheap Brazilian Coffee.

Imports into England.

Foreign Transactions.—In Milburn's *Oriental Commerce* is given a statement of "the East Indies" coffee imported into England from 1802 to 1810. The total was in 1807, 2,721 cwt. "Company's" and *nil* "Private," while in 1809 there was *nil* Company's and 213 cwt. Private. Throughout the years indicated the imports fluctuated so greatly that the returns are of little value. It is, however, explained that it came from Moka, Java, Bourbon and Ceylon. No mention of India. About ten years later we read of a charter granted for an Indian plantation, and

Export from India.
Rise and Fall in Traffic with U.K.
Total Exports.
Indian Production.
Receiving Countries.
United Kingdom.
France.
Ceylon.

by 1853-4 coffee figured among the standard exports from India. In that year the supplies drawn by the United Kingdom from India were valued at Rs. 4,75,980. Ten years later (1863-4) they were Rs. 38,43,910; in 1873-4 they were Rs. 73,98,530; in 1883-4 they were Rs. 1,06,21,380; by still another decade (1893-4) they had begun to shrink, being then valued at Rs. 99,61,631. Turning now to the returns of the total trade for the past six years: the exports in 1901-2 were 255,042 cwt., Rs. 1,25,02,200; in 1902-3, 269,165 cwt., Rs. 1,32,12,628; in 1903-4, 291,254 cwt., Rs. 1,36,73,773; in 1904-5, 329,647 cwt., Rs. 1,66,09,757; in 1905-6, 360,182 cwt., Rs. 1,75,67,240; and in 1906-7, 228,094 cwt., Rs. 99,64,778. The Madras ports furnished the entire amounts, less a fluctuating quantity of from 1,000 to 10,000 cwt. exported mainly from Bombay. Of the receiving countries the United Kingdom heads the list, the consignments thence having been in 1901-2, 116,584 cwt., Rs. 64,25,838; in 1902-3, 155,501 cwt., Rs. 85,10,903; in 1903-4, 152,452 cwt., Rs. 82,71,186; in 1904-5, 187,344 cwt., Rs. 1,05,02,674; in 1905-6, 172,384 cwt., Rs. 96,74,780; and in 1906-7, 82,358 cwt., Rs. 41,22,420—a valuation about equal to that of the supply taken by the United Kingdom in 1883-4. These returns thus allow a comparison to be made with the valuations quoted above of the Indian exports since 1853. After the United Kingdom, France has to be mentioned as the next most important receiving country of Indian coffee; during the past five years the exports to that country have averaged a little over 100,000 cwt. And after France comes Ceylon, which during the same period has taken on an average over 20,000 cwt. of Indian coffee a year.

World's Production.
Consumption.

The world's production of coffee has been estimated as close on 15 million bags (132 lb. each), of which 11¼ million bags are furnished by Brazil. The greatest coffee-consuming countries are Holland (18·82 lb. per head, calculated on population of 1900), Belgium (10·53 lb.), and the United States of America (10·60 lb.). After these come Germany (6·6 lb.), France (4·79 lb.), Austria-Hungary (2·17 lb.), and the United Kingdom (0·90 lb.).

Conclusion.—For further details of the Medicinal Properties, the Chemical Composition, the Fiscal Regulations (in India and England) and other such topics, the reader is referred to the library of technical works that exists on these and kindred subjects. Practically every report or book of importance has been consulted in preparing the present brief account, and the citation of publications, paragraph by paragraph, should therefore prove helpful to those who desire fuller details.

D.E.P., ii., 491-500.
Job's Tears.

COIX, *Linn.*; *Agri. Ledg.*, 1904, No. 13; *Fl. Br. Ind.*, vii., 99-100; GRAMINEÆ. Job's Tears, *gurgur*, *jargadi*, *sankru*, *jhonki*, *ka-sí. kessi*, *kesai*, etc., etc.

History.
Beads (Bedes)

History.—So much attention was given by the early botanical writers to the subject of *Coix* that the inference might be drawn that it must formerly have been a plant more extensively cultivated than at the present day. It is generally believed to be the *Lithospermon* of Pliny (bk. 27, ch. xi. (Holland, transl.), 1601, ii., 284). In most of the early works *Lithospermon* or *Coix* is spoken of, however, as a wild plant, or one cultivated as a curiosity only. Gerarde, Parkinson, Miller, etc., all allude to the use of the seeds as beads (bedes). The circumstance mentioned by some of the more directly botanical authors, such as Rumphius and Loureiro, that coix was regularly cultivated in Eastern countries as an article of food, seems to have escaped consideration.

One of the most beautiful of the early drawings of this plant is that given by Besler (*Hort. Eystett.*, 1613, ii., 13, fol. 6, f. 1). So accurate, in fact, is Besler's picture that it might be reproduced as a modern sketch. But this is not the only interest in it, for in the text the grain is described as striated, a peculiarity, it may be added, that is possessed alone by the cultivated edible forms of the plant, although no mention is made of its being edible. The plant is also figured by Jacobus Bontius under the name of *Milium Solis* (*Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 152). Turning from these European records to those of the East, we are informed by the authors of the *Pharmacographia Indica* that the seeds are "mentioned in Vedic literature and appear to have been one of the cereals which were cultivated by the Aryans on the hill slopes of the Himalaya." "The Arab travellers in the East became acquainted with the seeds and named them *Damu Daud*—"David's tears," and afterwards *Damu Ayúb*—"Job's tears." Es-Saghani, who died about the year 1260, mentions them in the *Obáb* as a well-known strengthening and diuretic medicine. The Arabs introduced the plant into the West, and it has become naturalised in Spain and Portugal, where it is still known as Lagrima de Job."

Edible Forms.

Vedic Times.

Arab Names.

Carried to Europe.

Kasi.

It is significant that the word *kasi* (or some very similar word) should appear and reappear all over India as the vernacular name for one or other of the forms of this plant. Thus we have the *ka-si* of the Nágas on the north-east frontier of India, *kasei* in the Central Provinces, *kasai* in Gujarat, *kesai* in Berar, and the *cheik* or *kyeit*, *kulese*, and *kalinse* of Burma, and *kosen* in Japan. The word *ka-si* or *kesi* in India most frequently denotes a cultivated edible form. The cultivation as an edible grain is at the present day closely associated with the Mongolians, and its introduction and distribution in India may have been a consequence of the influence of that people; hence very possibly the explanation of the name *ka-si*. [*Cf.* Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 247.]

Mongolian Grain.

Forms.

Habitat and Distribution.—There are two undoubtedly wild forms of this plant and several cultivated states. By far the most widely distributed is ***Coix Lacryma-Jobi*** proper. This is met with in the Himalaya, Rajputana, the Central Provinces, Bombay, South India, Bengal, Assam, Burma and the Shan States. But its area extends to China, Japan, the Malaya, the American Continent (North, Central and South), the West Indies, Polynesia, the Mascarene Islands and Tropical as also Northern Africa, and it is cultivated as a garden curiosity in South Europe. It is thus met with throughout the tropics and in all warm temperate countries. The other wild species, ***C. gigantea*** (and its variety ***C. aquatica***), has a much narrower distribution, is a distinctly tropical plant, and is practically confined to India and Burma. Of the cultivated (or semi-cultivated) special forms of ***C. Lacryma-Jobi*** the cylindrical-fruited ***stenocarpa*** has been recorded as met with in the Naga hills, Burma, the Shan States, Tonkin and New Guinea. The flattened—spheroidal—form, the connecting link between ***C. Lacryma-Jobi*** and *var.* ***stenocarpa***, is the special bead form. It is a wild plant met with chiefly in Burma, the Malaya, China and Japan, and has been named by me *var.* ***monilifer***. Lastly, the fully cultivated and edible form, ***Ma-yuen***, is grown (so far as India is concerned) in the Central Provinces, Sikkim, the Khasia hills, Burma and the Shan States, and outside India it appears to be cultivated in Tonkin, China and the Malaya, but apparently nowhere else. Grisebach in his review of Botanical Geography (*Roy. Soc.*, 1846, 86) refers to the edible coix as a special feature in the most important area of production of that grain, viz. Eastern Bengal, Assam, Burma and the Malaya. In fact were a statement prepared of the geographical features of interest in the cultivated plants of British India, ***Coix*** would have to be commented on as characteristic of the tract of country that stretches east by south from Nagpur to Sikkim, Assam, Burma, the Malaya and China, and be regarded as an important food grain with some of the most ancient aboriginal inhabitants, especially those of Mongolian origin.

Ornamental.

Edible.

Mongolian Country.

Forms met with.

Species and Varieties.—In the *Flora of British India*, ***Coix gigantea*** has been treated as a variety of ***C. Lacryma-Jobi***, while ***C. aquatica*** has been regarded as a form imperfectly known. It seems probable, however, that all three are fairly distinct plants, separable from each other by constant characters. Whether they should be treated as but one species, with several fairly well-marked varieties, or two or more distinct species, may be open to doubt. It would seem the safer course, however, to accept them as constituting two species with several varieties under each. The best names, if not the most ancient ones (as already indicated), would be ***C. Lacryma-Jobi*** for the one and ***C. gigantea*** for the other. The latter is preferable to ***C. aquatica*** since it has become better known. The

Two Species.

species thus isolated are certainly very distinct. They differ in structure of leaf, flower and fruit, etc., as well as in habitat and economic properties. The wild states of ***C. Lacryma-Jobi*** have the capsular-spathe generally more or less spherical, and only slightly drawn out at the apex into a pyriform shape and obscurely angled and universally bluish-white (never chalky-white). The leaves are broad, often distinctly auriculate, quite glabrous, except for the double row of ascending teeth, along each of the veinlets of the upper surface—a peculiarity that gives the texture of the leaf the appearance of being embroidered and makes it backwardly hispid.

Gigantea-aquatica **Series.**

The ***gigantea-aquatica*** series of coix are always wild plants; ***gigantea*** is found on the lower hills—dry soils—a robust erect plant, the ***aquatica*** in swamps and most frequently as a floating weed, 20 to 100 feet in length. The capsular-spathe is invariably pyriform, much drawn out on the apex, the actual mouth cut obliquely into an elongated lip, which is often somewhat serrulate, ripe fruit prominently angled, and having two or three furrows along its flattened face, of a dull greyish-white to brown colour and very hard. The leaves are much shorter than in ***C. Lacryma-Jobi***, most frequently only faintly auriculate, and the upper (inner) surface is often marked by curious transparent glands, which in the young leaves are tipped with hairs; on the outside the leaves are quite glabrous except near the extremity of the sheath, where a few glands of an exceptionally large size are generally present.

Lacryma-Jobi Series.

The forms of ***C. Lacryma-Jobi*** in the wild state have the capsular-spathe invariably bluish-white, a colour which rapidly disappears under cultivation. In the variety known as ***stenocarpa*** the capsular-spathe is elongated until it becomes cylindrical, but when cultivated the tubes (so formed) change in colour chalky-white or become almost straw-coloured. In other forms, instead of ongating, the capsular-spathe becomes short and spherical, until fruits often not more than an eighth of an inch long are found and others more than double that ze, but always broader than long; hence the development in these examples may be said to be in the opposite direction to that in ***stenocarpa***.

Cultivated Forms.

When they exist as wild plants the shell in all forms of ***C. Lacryma-Jobi*** remains hard and polished, and, while it may darken in colour and become pink, brown or even black, is never found soft in texture nor chalky-white in colour. But under cultivation the spathe loses the bluish-white colour, becomes soft-shelled, and of a chalky-white or straw-colour to deep blue, brown or black; but in all these cultivated states it assumes a new character—viz. the leaf-sheath, on being transformed into what I have called the capsular-spathe, retains its veins as pronounced striations, so much so as to give the grain (in husk) a striped appearance. In the elongated semi-pyriform states of cultivated ***C. Lacryma-Jobi*** there is also a further peculiarity—viz. that a portion at the base of the fruit-spathe becomes constricted into a well-marked annular disc. The condition with a soft and striated shell and basal annulus appears to constitute the variety known to botanists as ***Ma-yuen***—a name given in honour of the Chinese General who is supposed to have first pointedly directed attention to the plant.

Edible Grain.

Cultivation as Food.—This curious edible grain might almost be said to be unknown to the inhabitants of India generally, except as a weed of cultivation. To many of the aboriginal tribes, however, such as those of the Central Provinces, Sikkim, Assam and Burma, it is an important article of diet. The plant grown as a regular field crop is invariably one or other of the many forms of the variety *Ma-yuen* already sufficiently described. But in times of scarcity the wild forms of these plants are (all over India) resorted to as articles of food. The grain is held to be sweet and wholesome, the only objections to it being the smallness of the supply and the hardness of the shell. In the forms specially cultivated the shell is soft and amenable to ordinary methods of milling.

Wholesome.

India.

Roxburgh was apparently unaware that coix had to be included among the edible cereals of India, though doubtless he had read Rumphius's description (1750) of its cultivation in the islands of the Malaya, also Loureiro's account of it in Cochin-China. In the *Agri.-Horticultural Society of India* (*Trans.*, 1841, viii., 348) mention is made of the grain being sent from Amherst. Mr. Riley, who presented the sample, said the

Khasia hills. **Yield.** **Burma.**

plant was of a "very hardy nature, and thrives upon almost any kind of soil, yielding a good amount of produce and in taste resembling wheat." Wallich identified the plant as ***C. Lacryma.*** J. D. Hooker, in his *Himalayan Journals* (1848, ii., 289), gives some interesting particulars regarding its cultivation in the Khasia hills. "Each plant," he tells us, "branches two or three times from the base, and from 7 to 9 plants grow in each square yard of soil; the produce is small, not above 30 or 40 fold." Mason, in his *Burma and Its People* (1860), published much useful information, and this has been brought up to date in the new edition by Theobald (1883, ii., 107). We there read that "Coix affords a good example of the results of cultivation of a wild plant the seed of which is of a stony hardness, but which is soft in the cultivated form and the kernel sweet. It is much cultivated by the Red Karens, and may be often seen for sale parched in the bazaars."

Diversities in Grain. **Ancient Knowledge.** **Roasted; husked.** **Boiled.** **Milled.** **Baked.**

In the article published in *The Agricultural Ledger* I have given a full account of the collections recently furnished to the Reporter on Economic Products from very nearly every important locality of India; I have quoted, under the special forms, the practical observations of the local authorities. This course was deemed preferable to a compilation of data into a common paragraph on cultivation, of facts and opinions that would seem in many cases only applicable to the individual forms of the plant. It may, therefore, be accepted as undesirable to republish that information in order to support the statement that there exists in India a fairly extensive and certainly a widely dispersed cultivation of the plant. There are great diversities in size, shape and colour of the grain, as also in quality and purpose to which put. These diversities, confirmed by the existence of many vernacular names, establish belief in an ancient knowledge, as possessed by the aboriginal (especially Mongolian) tribes of India. It has been affirmed that very possibly the pastoral Aryan invaders grew this grain on the slopes of the Himalaya, anterior to their becoming localised and assuming cultivation as a craft. But it is much more probable that the grain was distributed over the plains of India in close association with the Mongolian conquests. From Darjeeling and through Bhutan to the mountains of Upper and Eastern Assam, the Khasia, Garo and Naga hills, etc., to Burma and the Shan States, coix might be described as not only a fairly plentiful crop but an exceedingly important article of diet. Certain forms of the grain are roasted, then husked and eaten whole, being either parched (as with Indian corn) or boiled as with rice. Other forms are so very different that the grain may be milled and ground to flour (*átá*), and thereafter baked into bread. It seems probable that the properties that necessitate so very different methods of treatment and preparation involve a diversity chemically and structurally quite as great as that which exists between the hard and the soft wheats or the glutinous and the starchy rices.

China. **Tonkin.**

[illegible] Romanet du Caillaud (*Bull. Soc. d'Acclimat.*, 1881, viii., 442–4) tells us that in the 1st century A.D. the Chinese General Ma-yuen conquered Tonkin and became so fond of the Annamite grain *bo-bo* (the *y-dzi* of the Chinese) that he carried away several cart-loads of seed, and thus introduced its cultivation into China. Bretschneider (*Bot. Sin.*, 1895, pt. iii., 384) says of coix that it is cultivated near Peking under the name *ts'ao-tsz'th.* He then adds that there are two varieties, one with white, the other with grey coverings to the fruits. "I have also observed," he adds, "in the druggists' shops a variety (or species) with small oblong, pointed fruits." The oblong, pointed fruit might be *C. gigantea*, and, if so, it would be most interesting to find that species in China. Many writers have given their opinions on the coix grain of China. It is often spoken of as the *ee-jin* or *ee-yin*, and is reputed to be one of the most remarkable of foods. Dr. Smith wrote that it is larger and coarser than pearl barley but equally good for making gruel.

Japan.

Tea.

In a small book on the *Useful Plants of Japan* (issued by the Agricultural Society of that country) it is called the *tomagi* or *hatomagi*. "It is an annual cereal grass cultivated on common dry land. The stalks grow *to a height of 4 to 5 feet. The grain, pounded in a mortar and cleaned,* is consumed as meal and *mochi*. An infusion of the parched and ground grain is used instead of tea and is called *kosen*. A Chinese variety of larger grains, greyish brown in colour, with thinner shells is more easily crushed and cleaned." A gruel of the flour is specially commended by Du Caillaud for use in hospitals. The Chinese use the grain in soup, as pearl barley is employed in Europe.

Malt Beer.

Gruel.

Different Qualities.

Dzu.

Aroma.

Manufacture of Beer.—The references to the Japanese habit of drinking a decoction of the grain, and to the preparation of gruel and tea from it, necessarily suggest the more extended use in the manufacture of a kind of malted beer which in the Naga hills is called *dzu* (p. 758). But a surprising feature may be said to be the circumstance that the *dzu* made from one grain is of a much superior flavour to that from another, and, further, that the *dzu* of one grain may be kept for months, while that from another goes bad in a few weeks. I have personally experienced much pleasure, while travelling in the Naga hills, in partaking of the fresh *dzu* offered in friendly salutation. It is something in flavour between that of butter-milk and cider, and on a hot day at the termination of a long march is most acceptable. Some of the forms of coix (like many rices) have a rich perfume, and such grains when used in the preparation of beer are said to give it a fruity flavour and delicate aroma (see **Eleusine**, p. 520).

Medicine.

Diuretic.

Wild Form.

Medicinal Properties.—A missionary, writing of Tonkin to M. Du Caillaud, said that "Job's tears" made a refreshing drink, was a good blood-purifier and excellent diuretic. The gruel prepared from the ground seed, he observed, as also *Eau de Larme-de-Job*, was extensively employed in the summer to cool the body. By the Tonkin people it is spoken of as the "grass of life and health," is believed to neutralise the miasma of the air, and to purify water when boiled like tea with a quantity of coix flour and set by to cool before being used. In India coix can hardly be said to enjoy any reputation for medicinal virtues. The Rev. Dr. Campbell tells that among the Santals the root is given in strangury and in the menstrual complaint known as *silka*. Dymock (*Veg. Mat. Med.*, 1885, 853) says the seeds are sold in the drug-shops of Bombay under the name of *kassai-bij*. The authors of *Pharmacographia Indica* add that the wild form only is used medicinally, and that it is considered strengthening and diuretic.

Chemistry.
Wild and Cultivated Grain.

Chemical Properties.—The grain of coix, both wild and cultivated, has been subjected to chemical tests, and the somewhat conflicting results obtained are possibly due to the botanical position of the particular plant under examination not having been previously ascertained. In Church's *Food-Grains of India* (1886, 60) occurs the following remark: "In the sample of this grain which gave" the under-mentioned "analytical figures it was found that the edible seed after the removal of the hard and shining grey husk did not weigh more than one for every four parts by weight of the whole grain operated upon." In the *Kew Bulletin* (1888, 267) is published Church's second examination—and this a specimen, admittedly, of the cultivated grain. "From four parts by weight of the sample," he says, "three parts of husked grain were obtained—three times the quantity yielded by *C. Lacryma*" (presumably the comparison drawn is to the sample reported on in the *Food-Grains*, which I have assumed may have been a wild grain). Subsequently Church gave his third analysis in the *Supplement to the Food-Grains* (1901, 3), the grain examined having been cultivated coix of the Khasia hills. The following sets forth the practical results of the first and third of these examinations :—

	NUTRIENT RATIO.	NUTRIENT VALUE.
Wild Coix (presumably)..	1 : 3·8	89
Cultivated, Khasia hills..	1 : 4·4	90

Rich in Albuminoids.

Commenting on his final results, Church says that the quantity of albuminoids approaches to that of some kinds of pulse, and that the proportion of oil or fat is larger than that present in the great majority of cereals. In *The Agricultural Ledger* will be found the chemical results obtained by several other investigators.

Industrial.

Beads.

Industrial and Domestic Uses.—From a remote antiquity both in Europe and in India, the grains or seeds, especially of the wild plant, have been used as the beads of rosaries. By the aboriginal tribes of India and Burma they are employed in personal adornment. Necklaces, earrings, head-dresses, etc., are often largely composed of them, and dresses, bags, baskets, etc., extensively ornamented with them. For these purposes a semi-cultivation has been pursued, possibly for centuries, that has resulted in the development of special grains, in cylindrical or spheroidal forms, and in a rich variety of colours. In Nepal, Oudh, and among the hill-tribes of the central tableland of India generally, they are employed either by themselves or in conjunction with cowrie-shells in the decoration of baskets, agricultural implements and cattle. By the Karens of Burma the cylindrical grains cover certain portions of dress, and are elaborated in designs that simulate (or perhaps may have suggested) some of the patterns seen in embroidery. With the Angami Nagas, earrings are constructed that consist of a rosette of the elongated seeds surrounding the metallic green wing-cases of a beetle.

Angami Earrings.

Trade.

Curtains.

TRADE.—The possibility of a profitable expansion of the industrial uses of these seeds to a large extent suggested the inquiry, the practical results of which have already been set forth. A fairly large trade exists in the seeds, and they are used in the construction of Japanese bead door-curtains. An exceptionally large kind—a form of ***C. aquatica***—was discovered by me in Poona, utilised in the construction of such curtains. It seems probable that ***C. gigantea*** and ***C. aquatica***, together with some of the larger forms of ***monilifer***, are most likely to be worked up in that manner. But in discussing possible future industrial developments it is essential that the separation indicated into the forms of ***C. Lacryma-Jobi*** that are cultivated and those that are wild should be clearly kept in mind. Cultivation destroys very rapidly the hard pearly shell, upon which to a very large extent the industrial demand depends. It also changes the colour of the grain and produces dull chalky whites and straw-colours, utterly devoid of the rich glossiness of the wild grains. By the selection and partial cultivation of spontaneous varietal forms or sports (such as those named ***stenocarpa*** and ***monilifer***) these dangers are ever present. This fact is fully appreciated by the Burmese experts, and the cultivation, partial though it be, is abandoned for a time or fresh stock secured from the jungles, when regression has been observed. It is thus difficult, if not impossible, to guarantee a continuous supply of any one shape, size, or colour of grain, and this may at once be admitted as (from the European point of view) a serious obstacle to a

Changes with Cultivation.

Continuous Supply.

European Uses.

greatly increased demand. The smaller and more gracefully formed examples of ***monilifer*** and of ***stenocarpa***, it would seem, stand a fair chance of coming into use in Europe as beads, especially in the construction of bugle-trimmings and as buds and other special portions of artificial flowers. They would be cheaper, more durable, than the glass at present used, and since they may be dyed any desired shade of colour, they might be extensively employed in dress-trimmings. And doubtless the difficulty of producing and maintaining certain sizes and shapes of grain would soon be overcome were a profitable demand to arise for a larger production than at present exists.

D.E.P., ii., 501-2.
Colchicum.

COLCHICUM LUTEUM, ***Baker*: *Fl. Br. Ind.*, vi., 356; LILIACEÆ. A small plant found on the grassy slopes of the Western Temperate Himalaya.

Two Forms.

Poisonous Seeds.

The corms (or bulbous roots) constitute the bitter *hermodactyl* of the later Greeks, and are the *surinjan* of the Indian bazárs. The true COLCHICUM (***C. autumnale***) does not occur in India, but in the bazárs there are two forms sold, the bitter and the sweet. The latter is imported from Persia. European physicians in India consider the sweet root as inert, but they would seem to hold that the bitter one possesses similar properties to the true colchicum and may be substituted for it. Recently a few children were reported to have been poisoned at Kuldana in Rawalpindi through eating the seeds of this Indian colchicum. The seeds were accordingly chemically analysed at Calcutta (as also the roots), and tested physiologically. It was found that both possessed *colchicine*, of which the hundredth part of a grain proved fatal to cats. [*Cf.* Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1902-3, 28.]

D.E.P., ii., 509-11.
Kachú.

COLOCASIA ANTIQUORUM, ***Schott.*: *Fl. Br. Ind.*, vi., 523; Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 144; Rumphius, *Herb. Amb.*, 1750, v., 313, t. 109; Forster, *Pl. Esc.*, 1786, 57; *Arum Colocasia, Roxb.*, *Fl. Ind.*, iii., 494-5; *Taleef Shereef* (Playfair, transl.), 1833, 12-3; Nicholls, *Textbook Trop. Agri.*, 290-3; Duthie and Fuller, *Field and Garden Crops*, iii., 8, t. lxxv.; Mollison, *Textbook Ind. Agri.*, iii., 191-3; *Rec. Bot. Surv. Ind.*, i., 86, 277; ii., 25, 147; 1905, iii., 296; Prain, *Beng. Plants*, ii., 1112; Wiesner, *Die Rohst. des Pflanzenr.*, i., 566; AROIDEÆ. The Taro, Eddoes, Scratch-coco, Tania, Egyptian Arum; in the vernaculars *kachú* or *katchú*, *kachchi*, *arvi*, *arvis*; *dzu* (cultivated) and *kirth* (wild) Naga hills; *ráb* (Pb.); *álú*, *terem* (Bombay); *shámá-thúmpa* (Tel.); Tahitian *tallo* or *tarro*, Malayan *tallas*, etc.

Habitat.—A tall, coarse, tuberous herb, wild and cultivated both in moist and dry situations over the greater part of tropical India and Ceylon up to 8,000 feet (in the Himalaya); cultivated, in fact, in all tropical countries.

Description.

Pot-herb.

The plant has large heart-shaped leaves, borne on long footstalks which rise from a short farinaceous underground stem or corm. The corm constitutes an important article of food with the Natives of India, and the young leaves are often eaten in the form of spinach. The plant is in consequence fairly extensively cultivated, and special races have been evolved to suit every condition of soil and climate, from the swamps of Lower Bengal to the moist hills of Assam and Madras, to the dry uplands and lower hills of the Deccan and Rajputana and even to the temperate tracts of the Himalaya.

Wild Forms.

Wild and Cultivated Forms.—The wild plant, which is extremely plentiful in the moist tropical regions, produces but rarely an edible tuber though its leaves are often eaten. Roxburgh describes three special wild forms:—*kalla kachu*, a plant with purple leaves found on the edge of ditches—the leaves and leaf-stalks are eaten; the *char-kachu*, which has the leaves clouded with bluish-black; and the *ban-kachu* with green leaves. These are found on roadsides and homestead lands, but above inundation level.

Cultivated Forms.

Roxburgh also mentions two cultivated forms, the *guri-kachu* and the *asu-kachu* (or early *kachu*). Small corms of these are planted in May or June, the *asu* being reaped towards the end of the year and the *guri* not until February or March. Lastly Roxburgh mentions, as a distinct species, a special form of

C. antiquorum, viz. ***nymphæifolium***, the *sar-kachu*, which frequents aquatic situations and produces corms that attain the length and thickness of a man's arm. Engler (in DC., *Monog. Phaner.*, ii., 491) refers the forms of ***C. antiquorum*** to seven varieties, three of which are met with in India. Duthie and Fuller say that two varieties appear to be grown and distinguished by their roots, viz. *dholi ki gagli*, the white- and *káli ki gagli*, the dark-coloured. The word *gagli*, they observe, refers strictly to the young off-sets, the main root being known as *dendu*. Nicholls (*l.c.* 292) says that there are two principal varieties, one with green stems and leaves and the other with purplish ones, but that the tubers are identical in both kinds. Numerous vernacular names are given to cultivated races of this plant all over India, but in the present state of knowledge it is impossible to assign them any more distinctive positions than those indicated above.

Soils.

Propagation.

Bombay.

Off-sets.

Cawnpore.

Madras.

Cultivation.—The following account of the method of propagation usually adopted is given by Nicholls:—"The best soil is a sandy loam with an abundance of organic matter in it. The plant does not do so well on clayey soils, and it does not thrive on pure sands. . . . The plants are propagated in the same way as are yams. That is, when the crops are reaped, the head of the tuberous rhizome is cut off and the leaves are detached, leaving a few inches of the lower part of the leaf-stalks. These heads are then planted, and soon a number of plants bud forth from the top of the head and produce a crop of *tanias*. The heads may be kept some time before planting without suffering any harm, and thus they may be carried to long distances." Nicholls also observes that the tubers may be left in the ground without deterioration for a considerable time after they are ripe, so that they can be dug up as they are required. Mollison, speaking of Bombay, says that the crop is rarely grown over a large area. Patches are raised in the back yards of houses, and in the garden lands of Gujarat it is common to find a patch near a well, with single plants at the corners of beds of other irrigated crops. "When grown alone," he continues, "the land is carefully prepared as for other garden crops, and laid out into beds 12 feet by 6 feet for irrigation. Forty plants occupy each bed. The crop should be freely manured and watered, also weeded as required. Off-sets should be removed before they root, unless it is desired that the whole surface should be covered with plants. This is, perhaps, advisable when the crop is grown under sewage irrigation for the value of its leaves and leaf-stalks. If grown for its corms, the plants should be 12 inches apart. It takes ten months for the corm to reach maturity. When the crop is planted four or five months, the leaves and stalks may be gathered every three or four days. They should be cut off close to the ground whilst young and tender. A few older leaves should always be left to preserve healthy, vigorous growth." Duthie and Fuller state that in the Cawnpore district the average outturn is only 50 maunds (less than 2,000 lb.) per acre. In Coimbatore, however, the yield has been recorded as 6,250 lb. per acre.

Uses.

Food.

Utilisation.—The corms contain much starch and constitute an important article of food throughout the country, especially with the lower classes, and in some districts, such as Travancore, the corms are of very special value. They are usually scraped or partially peeled, cut up into small pieces, and boiled like potatoes. After boiling, the soft pieces are often fried in butter (*ghi*) or oil and the usual Native condiments added. Sometimes also they are pounded into a paste, and in New Guinea they are said to be ground into flour and made into biscuits. A pickle prepared from the main root (*dendu*) with chillies, salt and lime-juice is sold in the bazárs. The bazár rate for the vegetable is said to be about 1½ maunds for one rupee. Mollison observes that the stalks and leaves are cooked either separately or together. If separately, the fibrous cuticle of the stalk is removed and the inner part cut into short pieces and cooked with condiments and *gul*,

Leaves and Stalks.

Fodder.

To this preparation is added boiling oil (*phodni*) in which mustard, turmeric and spices have been mixed. The prepared dish is a sweet curry. The leaves are used as a *ság* or are chopped fine with the stalks and made into a curry. There are numerous other preparations of *kachu* leaves and stalks. Nicholls says that the mature leaves and stalks are an excellent fodder for cattle and food for pigs.

Chemistry.

All parts of the plant contain an acrid principle which is commonly supposed to be extracted by boiling. Thus on account of this acidity the juice of the petioles is often employed as a domestic remedy, being regarded as styptic and astringent. But this acrid principle was investigated in 1888 by Pedler and Warden in the case of the species ***C. virosa***, *Kunth.* (*bish kachu*), which alone is regarded by the Natives as poisonous and never eaten. The results of the above investigation were recorded in the *Dictionary*, and it may suffice to say that the poisonous principle was discovered to be due to very numerous bundles of crystals of oxalate of lime, and thus to mechanical irritation similar to that produced by cowhage (***Mucuna pruriens***) or chopped hairs administered in food. The crystals, it may be observed, are indissoluble in boiling water, but are rendered inert by water slightly acidulated with hydrochloric or nitric acid, and to a less extent with acetic acid. Hence in preparing ***Arum*** tubers for food the Natives almost always add an acid vegetable or fruit such as tamarind.

D.E.P., i., 365-70.
Myrrh.

COMMIPHORA, ***Jacq.*** **(Balsamodendron,** *Kunth.*); *Fl. Br. Ind.*, i., 529-30; Engler in DC., *Monog. Phaner.*, iv., 7-29; Engler and Prantl, *Pflanzenfam.*, iii., pt. 4, 251-6; *Index Kew.*, i., 593, suppl. i., 108; ii., 46; BURSERACEÆ. A genus of small spiny, balsamiferous trees containing some 80 species, of which 60 are African and only 5 Indian. Some yield Bdellium, others Balsam, and others Myrrh.

Assam Bdellium.

C. Agallocha, *Engl.*; *Amyris Commiphora, Roxb., Fl. Ind.*, ii., 245; *B. Roxburghii, Arn.*; *gugala, gugal, mhaishabola, gugar, gukul*, etc. It bears, in fact, the same names as the next species. A native of Eastern Bengal, Sylhet and Assam. It was formerly supposed to yield Indian bdellium or *gugal*, but its gum is now said to be used only as an adulterant of, and not as a substitute for, myrrh.

Indian Bdellium.

C. Mukul, *Engl.*; Indian Bdellium, *gugala, guggul, gúgal, gukkal, mukul, maishákshi* or *maisáchi, koushikaha*, etc. A tree found in the arid zones of Sind, Kathiawar, Rajputana, Berar and Khandesh. A gum exudes from incisions on the bark made in the cold season. It occurs in vermiform pieces of a brown or greenish colour, and is put on the market as a substitute for African bdellium. The Indian supply comes very largely from Amraoti and is used in Bombay, mixed with mortar, as a fine CEMENT (p. 293). It is employed MEDICINALLY in leprosy, rheumatism, etc. Dutt (*Mat. Med. Hind.*, 1900, 132-5) says that "old *guggulu* is dry and without flavour or colour, and should not be used in medicine." Moodeen Sheriff (*Mat. Med. Mad.*, 1891, 93) remarks that the wholesale price is Rs. 4 per maund and retail 3 annas per lb.

Amraoti.
Cement.
Price.

Imported Gums.
Bdellium.
Balsam.
Myrrh.
Prices.

The commercial interest in the products of this genus centres on the foreign supply largely imported into Bombay. Of these mention may be made of Bdellium and Bysaból from Africa; Balsam of Mecca (*mor, balásán*), an aromatic oleo-resin from Arabia; and Myrrh, both that which comes from Africa (Somaliland) and that from Arabia. The best is the *karam* or *banda rkaram*, and the second quality the *meetiya* or *chenai-bol*. Recently Europe has begun to import these products direct instead of *viâ* Bombay. The value of *bandar karam* at Bombay is given as Rs. 34 per maund of 37½ lb., *meetiya* Rs. 16 to 25, refuse Rs. 8. In 1808 the East India Co. imported into England 53 cwt. of myrrh valued at £1,014 = £19 2*s.* 7*d.* per cwt. The present-day price is about £5 per cwt, but exact particulars of the import and re-export trade are not available. It is possible that some portion of the transactions mentioned under **Boswellia** (p. 174) belong in reality to ***Commiphora***. [*Cf. Kew Bull.*, 1896, 91-4; *Kew Mus. Guide*, 1907, 39-40.]

Red Zanzibar.

Holmes (*Pharm. Journ.* (ser. 4), iii., 506) says that myrrh now reaches London direct from Arabia and Abyssinia. When it comes from Bombay it is called Red Zanzibar. He has also urged that it would be preferable to retain the name ***Balsamodendron*** in preference to substituting ***Commiphora***. [*Cf.* Tschirch, *Die Harze und die Harzbehälter*, 1906, i., 391-410.]

D.E.P., ii., 647–50.
Copper.

COPPER AND BRASS: Cuprum, Its Ores, Salts, Alloys and Manufactures; Ball, *Man. Econ. Geol. Ind.*, 1881, 239–80; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 102, 131, 164, 198–200; King and Pope, *Gold, Copper, and Lead in Chota Nagpur*, 1891, 95–170; Holland, *Copper Mine of the Pat-Pat Gold Mining Co., Singhbhum*; Foote, *Geol. Bellary*, in *Mem. Geol. Surv. Ind.*, 1895, xxvi., 197–9; R.E.P., *Rev. Min. Prod. Ind.*, 1894–6, etc.; *Ind. Art. at Delhi*, 1903, 16–7, 52–62, 475–6; Hayden, *Rec. Geol. Surv. Ind.*, 1904, 1–4; *Mem. Geol. Surv. Ind.*, xxxi., 172–3, 291–4; Holland, *Rev. Min. Prod.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 104–5. The *tanbáh, támá, támra, trambú, támbra, nohás, mis, shenbú, rági, kaiyení*, etc. (copper and copper-ore); *pital* (brass); *kánsa* (bell-metal).

Occurrence.

Smelting.

Chief Localities.

Mining Leases.

Ancient Workings.

COPPER METAL: Occurrence and Production.—For detailed information regarding the Indian mines and sources of copper ore, the reader is referred to the publications mentioned above. The indigenous industry of copper smelting may be said to have been dormant in India for many years, though some short time ago expectations of its revival were entertained in connection with two localities in Bengal, viz. Singhbhum and Darbhum. More recently discoveries of some value have been made in Darjeeling, Chanda, Garhwal, Assam and Baluchistan, etc. An elaborate historical account of the Chota Nagpur copper-fields is given by King and Pope in the work cited above, and will repay perusal. Holland says that copper was formerly smelted in considerable quantities in South India, Rajputana, and at various parts of the outer Himalaya, where a killas-like rock persists along the whole range and is known to be copper-bearing in Kullu, Garhwal, Nepal, Sikkim and Bhutan. He adds that all attempts by European companies to open up the deposits have proved unsuccessful and the Natives no longer work the ore themselves. Nevertheless mining leases are still held and prospecting licenses are frequently granted for copper-ore. It will be seen from the statistics of the imports of foreign copper and brass that if a paying deposit could be opened there is a large annual demand in India which might be contested. It may be said of the ancient workings that they very rarely reached the pyritic ore because with their simple and inefficient appliances they were unable to cope with the flow of water which followed their mining operations. Hence the ore smelted was principally oxides and carbonates.

Works.

Smelters; Foundrymen; Coppersmiths.

Chief Centres.

Hand-labour.

Indian Copper and Brass Workers.—There may be said to be three classes of operatives concerned in the copper and brass trade, viz. smelters, foundrymen, and coppersmiths. Every village has its trade in copper vessels, and most have, in addition, their coppersmiths. The iron and brass foundries are often treated conjointly, so that separate statistical returns cannot be furnished. Thus in the *Moral and Material Progress of India* (1905–6, 178) the number of workers for 1905 is stated to have been 24,300. It has been repeatedly pointed out that there is a tendency for the copper and brass industry to become more and more concentrated in the towns, a movement which must contribute to its better organisation. Certain centres having become famous for their copper and brass manufactures are securing a large proportion of the total trade and drawing the best workers away from the villages. Nevertheless the industry as a whole is said to be in a secure state compared with many of the other indigenous crafts, and this result is largely a consequence of the essentially hand-labour character of much of the goods turned out.

Statistics of the Indian outturn of copper are not available, but in the concluding paragraph will be found full particulars of the foreign trade, and these give the most accurate conception possible of the Indian coppersmith's craft.

Copper and Brass Wares.

Copper and Brass Wares.—The *tambá* (Copper), *pital* (Brass), *jasta* (Zinc), *rangá* (Tin and Pewter), and *sisa* (Lead).

Brass.

Bell-metal.

Each province has two or more centres noted for copper and brass works, hence the diversity of art designs in the ornamentation of these metals. Brass is an alloy of copper and zinc usually in the proportion of 2 to 1 or 4 to 3, but it is rarely made in India, being generally imported as sheet-brass. A cheaper but inferior alloy of copper, zinc and tin is called *bharat, kaskut*, or *kansá*. But *phúl* or *kansi* is the most constant of Indian alloys and corresponds to the bell-metal or white brass of Europe. It is a bright metal, takes a high polish, and is composed of copper and tin in the proportion of 7 to 2. Hoey mentions the *kasbharas* are the vendors (not themselves the manufacturers) of ornaments made from an amalgam of copper and zinc. The actual manufacturers are *dhaliyas* or *bhariyas*, the former casting in stone moulds, the latter in clay.

Restrictions.

In the Hindu order of purity gold is followed by copper, silver, brass and iron. Brass is detestable (*makrúh*) to the Muhammadans, who prefer earthenware, but copper may be tinned and approved in that form. The Hindu ceremonial law prohibits *phúl* or bell-metal as containing pewter (*rangá*). This is unfortunate, since *phúl* is by far the most sanitary metal in India, and in it acid materials may be cooked and milk and curds kept, whereas such is not the case with copper or brass.

Casting.

Domestic Vessels.

Indian craftsmen manifest a wide knowledge of the technique and utilisation of these metals and their alloys. The huge brass idols of Burma are cast with appliances and by a staff of operators absurdly inadequate when judged by European standards. Chain bangles and anklets (*santh*), often worn by the peasants, are moulded in Rajputana and elsewhere and sold at a few annas a pair that could not be manufactured in Europe or America at so small a price. [*Cf. Textile Journ.*, 1891, i., 78.] Between these extremes in magnitude and intricacy may be said to lie the long range of domestic and sacred utensils, in the production of which the craft has drawn to its ranks men of nearly every caste in addition to the hereditary workers, the *kaseras* and *thatheras*.

Lota.

Tonti.

Domestic vessels are rarely ornamented because, by ceremonial law, they must be scoured with mud before being washed with water. The commonest copper or brass vessel of the Hindus is the globular melon-shaped *lotá*, which is flattened from the top and possessed of an elegantly reflexed rim. It is doubtless modelled after the expanding lotus-flower (*Nelumbium speciosum*). The Muhammadans have given the *lota* (or, as they call it, the *tonti*) a spout, in order to secure an approach to the running water ordained by the *Koran* for their ablutions. The spouted water-pot has given rise to a totally different series of metal-work, both domestic and decorative, from those connected with the Hindu *lota*. And perhaps to this may also be traced the broader (transverse) developments of Hindu and the narrower (more longitudinal) designs of Muhammadan art.

Artistic and Ceremonial.

Ceremonial implements and the vessels elaborated from these are richly varied in shape and ornamentation. Examples are the *kosa* or *panch-patr*, a spathe-like vessel used in raising water; the *kusi* or *achmani* or spoon used by the priests in sprinkling holy water; the *dhupdáni* or censer; the *sinhasan* or idol-throne of lotus-leaf pattern; the hanging lamps (*arti*); the bells (*ghantá*), and in particular the chains by which these are suspended in the temples; and the designs usually adopted for idols, especially those portraying the youth and pastoral existences of *Krishna*, are all highly artistic and have contributed very greatly to Indian conventional art. The following publications will be found useful as reviewing the chief centres and styles of Indian copper and brass work:—

Literature.

Panjáb and Northern India: Kipling, *Journ. Ind. Art*, 1884, i., pt. 1.; *Old Kashmir Copper Ware, l.c.* pt. v.; also *Copper and Brass, Delhi, l.c.* 1887, *Amritsar*, and *Lahore*, 1888; Johnstone, *Monog. Brass and Copper Pb.*, 1888; C. H. B. in *Civil and Military Gaz.*, Jan. 5, 1902. United Provinces: *Benares Ware, Journ. Ind. Art*, 1885, i., pt. 7; Moradabad Ware, *l.c.*; Crooke, *Copper and Brass in Mirzapore, l.c.* 1893, No. 44; Dampier, *Monog. Brass and Copper U. Prov.*, 1894. Rajputana and Central India: Hendley, *Jaipur Mus. Cat.*; *Brass, Copper and Mixed Metal-wares of Jaipur, Journ. Ind. Art*, 1886, i., No. 12; *Jaipur, Lucknow, Kashmir, Copper and Brass, etc., l.c.* 1891, No. 35. Bombay: *Hammered Copper in School of Art, Journ. Ind. Art*, 1886, i., No. 11; *Brass and Copper Bom-*

bay, Journ. Soc. Arts, 1895–7, vii., No. 55, 13. MADRAS: Heyne, *Tracts on Ind.*, 1814, 108–17; *Tanjore Work, Encrusted Ware, Journ. Ind. Art*, 1886, i., No. 14; Holder, *Monog. Brass and Copper Wares, Madras.* CENTRAL PROVINCES: *Monog. Brass and Copper Ware*, 1894. BENGAL: Mukharji, *Art Manuf.*, 1888; *Monog. Brass and Copper Manuf.*, 1894. ASSAM: Gait, *Note on Copper and Brass Wares in Assam*, 1894; *Ind. Art at Delhi*, 1903, 42–52.

Blue-stone.

Sulphuric Acid.

Record of India's Losses.

Development of India's Productive Resources.

Sulphuric Acid.

Germany's Prosperity.

COPPER SALTS.—The most important is the ***Sulphate***—Blue-stone, *nila-thúthia* (*níla-tutia*), *mor-tuttá*, *mayil-tuttam*, *turichu*, *qalqand*, *doutha*, etc., etc. Speaking of this salt, Holland observes: "For many years pyritous deposits in India have been turned to account for the manufacture of soluble sulphates of iron and copper," as also in the manufacture of alum—the double sulphate of alumina and potash. He then discusses the importance of the manufacture of sulphuric acid (see pp. 50–1) as a link in the chain of production of many of the most important chemical and metallurgical industries—such as soap, glass, paper, oils, dyes, etc. He further points out that it is a by-product of such value as to admit of the smelting of ores which it would be impossible otherwise to undertake. But in Europe the price of sulphuric acid has been reduced, during the past 100 years, from £30 to £2 a ton, and in consequence this originated such activity and far-reaching competition as to have all but exterminated the ancient Indian manufacture of alum, copperas, blue-stone and the alkalis and akaline earths, reduced the export trade in nitre, rendered the smelting of copper and several other metals no longer profitable, robbed the country every year of nearly 100,000 tons of phosphatic fertilisers, and compelled India to pay ten million sterling for products obtained in Europe from minerals identical with those lying idle in India. Under the account of **Alkalis and Alkaline Earths** (pp. 50, 55) it will be found that this subject has been incidentally discussed already. So again under **Coal and the Manufacture of Coke** (p. 347) mention will be found of the loss to India of a valuable manure. Hence it may fairly be said that a more important and more immediate direction for developing India's productive resources could hardly be mentioned than the utilisation of her pyritous deposits by the modern economical methods pursued in Europe. As exemplifying this contention it may be pointed out that the production of sulphuric acid from iron pyrites was in Germany 358,149 tons in 1882 and 754,151 tons in 1898. Of that large quantity only 25,000 tons were exported; the balance was used up in the German chemical industries which within the past three-quarters of a century have expanded from a mere nominal value to a capitalisation of £50,000,000.

Indian Production.

Uses of Blue-stone.

The manufacture of copper sulphate as pursued in India at the present day is on a very small scale. The knowledge of its possible production from pyrites has been possessed by the people of India from a remote antiquity. The pure salt is, however, imported extensively from Europe. Medical writers, such as Dutt, give particulars of the methods of refinement pursued with the salt that is to be used for medicinal purposes. These are very possibly of questionable advantage. Blue-stone is extensively used in medicine, in dyeing, and as an ingredient in one of the best-known and most valuable fungicides—the "Bordeaux Mixture." (See **Camellia**, p. 229.)

Copper Acetate.

Copper Acetate, Verdigris (*zangár*), is manufactured by the *sirkakash* or vinegar makers. They buy up copper filings from the coppersmiths. These are put into a jar and covered with distilled vinegar (*araq*). The pot is closed at night but open during the day. After twenty-four hours the *araq* is poured off and mixed with water and left to evaporate until only the *zangár* remains. Copper acetate and the arsenite of copper are used as insecticides and as colouring reagents. *Zangár* yields a blue-green of great beauty. [*Cf.* Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 195.]

Trade.

Indications of Famine.

Fluctuations in Price.

Economic Barometer.

TRADE IN COPPER, etc.—O'Conor (*Rev. Trade Ind.*, 1898–9, 15) says, "The trade in this metal follows closely the fluctuations in its price and in the material condition of the people. In a time of scarcity and famine the imports fall in a marked degree, the copper utensils of the household being the first articles parted with in the pinch of distress. For the time earthen utensils are substituted, and the stock of copper in the braziers' shops accumulates. When plenty reigns again, copper pots are in active demand and the import trade is lively." The instability of price owing to the operation of speculators is another factor which adversely affects the Indian market. Any rise of price has an immediate effect in decreasing the demand for copper and throwing the people back to earthenware (*Rev.*, *l.c.* 1901–2, 9.) O'Conor returns to this subject and observes, "So much, however, is this trade a sort of economic barometer measuring the presence or absence of pressure on the people, that the figures of the trade merit attention :—

Imports.

Imports in Cwt. of Copper.

' 1896–7	240,648	1901–2	193,822."
1897–8	322,348	1902–3	395,850
1898–9	251,301	1903–4	433,091
1899–1900	90,846	1904–5	427,233
1900–1	159,971	1906–7	211,959

To the returns quoted by O'Conor have been added (as a matter of convenience) the figures for the years 1902 to 1906.

Price.

Decline.

Robertson (*Rev. Trade Ind.*, 1904–5, 8) remarks, "After five years of steady progress the imports of copper have fallen by 1·3 per cent. in quantity and 2·7 per cent. in value." "Owing to the rise of prices in Europe, caused by large demands for America and China, imports of both unwrought and wrought copper were greatly restricted during the last quarter of the year. The sensitiveness of the Indian demand to price changes is always noticeable, for besides its increasing use for industrial purposes, copper as the material for household utensils is an article of great importance in the domestic economy of the people, and their ability to satisfy their requirements is regulated first by their material prosperity, which is principally a question of good or bad crops, and secondly, by the commodity being cheap or dear." The ominous decline thus briefly indicated became even more marked in 1905–6, when it amounted to 36·5 per cent. of the quantity and 32 per cent. of the value. [*Cf.* Noël-Paton, *Rev. Trade Ind.*, 1905–6, 10.]

Brass.

But to obtain a full conception of the traffic it is necessary to add to the above imports of copper those in brass of all kinds. These fluctuate from 10,000 to 12,000 cwt., valued at from 6 to 8 lakhs of rupees. The grand totals for the years 1902–7 thus became :—1902–3, 407,494 cwt., valued at Rs. 2,03,28,458 ; 1903–4, 441,188 cwt., Rs. 2,23,37,805 ; 1904–5, 437,043 cwt., Rs. 2,16,65,708 ; 1906–7, 223,097 cwt., Rs. 1,46,88,046.

Sources of Supply.

The major portion of the imports come from the United Kingdom. Of the supply (copper only), 433,091 cwt., secured by India in 1903–4, the largest quantity imported in the last five years, the United Kingdom supplied 293,595 and each of the following countries furnished from 18,000 to 25,000 cwt., viz. Ceylon, Hongkong, Belgium, Germany and Japan. Bombay takes by far the largest share (228,874 cwt. in 1903-4), followed by Bengal (163,908 cwt.) and by Madras, a long way third (31,501 cwt.).

D.E.P., ii., 521-6. Títá.

COPTIS TEETA, *Wall.* : *Fl. Br. Ind.*, i., 23; *Hobson-Jobson*, (ed. Crooke), 1903, 548-9; RANUNCULACEÆ. Coptis or Gold Thread, *títá*, *mámírá* (? *mámírán*), *mahmira*, *pita-karosana*. A small stemless herb, with perennial root-stock, met with in the temperate regions of the Mishmí hills, east of Assam. The plants are said to grow on the ground among the moss around the stems of trees.

Very little, if any, additional information is available since the publication of the *Dictionary*, and the original article should therefore be consulted. Four reasons, it will there be found, were given for questioning the absolute identification of the tonic drug prepared from this plant with the "*mamirás*" of early European writers.

Supply.

The Bengal supply comes through Assam, but a Chinese root, the identity of which must be regarded as uncertain, is also imported into India. The latter may possibly be a different species of ***Coptis***, for it is to be observed that ***C. anemonæfolia*** affords a medicinal root in Japan, whilst ***C. trifolia***, *Salisb.*, yields both a medicinal root and a yellow dye in North America. [*Cf.* Wiesner, *Die Rohst. des Pflanzenr.*, ii., 477.] But the thicker Chinese rhizome as described by Dymock seems to recall some of the forms of *katki* or *kuru*, such as ***Picrorhiza Kurroa***, ***Gentiana Kurroo***, ***Coscinium fenestratum***, ***Swertia Chirata***, etc. It is just possible also that one or other of these roots may be sold as *títá* in the Upper and Western Provinces. Indeed J. D. Hooker was actually presented in Sikkim with a handful of the so-called "*teeta*," which he identified as ***Picrorhiza***. It would thus seem highly likely that that, being the most abundant Indian equivalent, may have been at an early date identified with the classical *mámirás*, and called *mámirán*. At all events it is largely sold throughout India and is frequently mentioned in *The Bower Manuscript* of date 5th century. Moreover it is worth noting that ***Coptis***, ***Berberis***, and doubtless many other yellow bitter drugs contain *berberine*, which, it would seem, constitutes their efficacy as eye-salves. For example, from Mussourie and other localities on the N.W. Himalaya the roots of ***Thalictrum foliolosum*** are collected and sold under the name *momiri*. Aitchison speaks of the roots of both a ***Corydalis*** and a ***Geranium*** being used in Afghanistan as a drug, which is there called *mámirán*. Two samples were examined by Mr. Bhaduri and found to contain 6·85 and 6·5 per cent. berberine respectively (*Rept. Labor. Ind. Mus.*, 1902-3, 29). In conclusion it may be noted that ***C. Teeta*** and the use of *mámírán* as an eye-salve were unknown to the Sanskrit medical writers—they are doubtless of Muhammadan introduction. (See **Berberis**, p. 130.)

Substitutes

Collyrium.

Apart from the utilisation of ***Coptis*** as a collyrium or eye-salve, the root makes a valuable tonic in the debility following fevers, etc., but it is not a febrifuge. There appears, however, to be a considerable demand for it in India, and it might be found profitable as a cultivated plant. But it may be here added that the Mishmi poison consists of a mixture of powdered *títá* with the pulp of an acid glutinous fruit such as ***Dillenia speciosa***. It is generally employed by hunters for killing wild animals. [*Cf. Pharmacog. Ind.*, iii. (app.), 92-3.]

Mishmi Poison.

Trade in *Títá*.

The Mishmís gather the roots of the *títá*, towards the end of the rainy season, and carry them, packed in tiny wicker-work baskets, to Sadiya, where they are bought by Assamese and Bengali merchants, apparently at about ½*d*. per oz. The drug found in Bombay comes from China *viâ* Singapore in bulk, the better and thinner root fetching about Rs. 3¼ per lb. and the second kind Rs. 2.

D.E.P., ii., 534-62; iv., 558-60. Jute.

CORCHORUS, *Linn.*; *Fl. Br. Ind.*, i., 396-8; TILIACEÆ. The Jute Fibre of commerce, Jew's Mallow; the *patta*, *júta*, *jata*, *kálasáka* of Sanskrit authors (according to Skeat, Dutt and others). It is, however, by no means very clearly nor fully indicated in the classic literature of

India. In the vernaculars it is the *pát, jhut, jhóto, jhuto*, etc. When specially used as a vegetable it is *nalita* or *nadika*—the *molochia* or *melochia* of the Arabs. The fibre is *pát, koshta*, etc., the coarse sackcloth woven of it and formerly used by the very poor in Bengal is *tát*, and the bags made of it are *choti* or *goni*.

Species.

Species and Varieties.—It may be said that there are two important cultivated forms of this genus and many wild species which are distributed throughout the tropics of Asia, Africa, and America. Geographical evidence is thus very nearly unavailing in any effort that may be desired to trace out the origin and history of the chief cultivated forms :—

Eastern Bengal and China.

C. capsularis, *Linn.;* Plukenet, *Alm. Bot.*, 1696, ii., 18, t. 255, f. 4; *Ganja sativa, Rumphius, Herb. Amb.*, 1750, v., 212, t. 78, f. 1; Lamarck, *Encycl. Bot.* (under *Corete*), 1786, ii., 104, t. 478, f. 3; Loureiro, *Fl. Coch.*, 1790, 334; Jones, *As. Res.*, 1795, iv., 297; Roxburgh, *Trans. Soc. Arts.*, 1806, xxiv., 146, 151; Carey, *As. Res.*, 1808, x., 11; Wight, *Ic. Pl. Ind. Or.*, 1840, i., t. 311; Jacquin, *Eclogæ Pl.*, 1844, ii., t. 119; Hooker, *Journ. Bot.*, 1850, 91–2, t. 3; Bretschneider, *Hist. Europ. Bot. Disc. in China*, 1898, 35, 239, 410; Sadebeck, *Kulturgew. der Deut. Kolon.*, 1899, 299–303; Jumelle, *Les Cult. Colon.* (*Indust.*), 1901, 41; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 330; Semler, *Trop. Agrik.*, 1903, iii., 654 *et seq*; etc., etc.

Description.

Fruit and Seed

Specific Separation.

This is the *ghi nalta pát* of Roxburgh (*Fl. Ind.*, ii., 581) and the *narchá* of Dutt (*Mat. Med. Hind.*, 1900, 302). The fibre is the true *pát* or *koshtá*, the latter name being possibly derived from the Sanskrit *kosha* a sheath and given in allusion to the fibres around the stem beneath the bark. It is recognised by its glabrous leaves, small flowers and subglobose, not beaked, but warted fruits. As pointed out in the *Dictionary*, however (*l.c.* 536), the fruit in the cultivated species of the genus ***Corchorus***, as in ***Brassica***, is very variable. It seems, in fact, probable that the peculiarities of the seed are much more constant than the shape of the fruit or the number of its carpels and valves. It is thus highly likely that this, as also the next form, are but cultivated conditions unworthy of the specific positions usually assigned to them. They are at all events each representative of groups of cultivated races that vary in colour of stem, shape of leaf, degree of hairiness, size of flower, shape and number of valves of fruit, etc., etc., until a panorama of specimens might be assorted that would not only break down the separation of ***capsularis*** from ***olitorius*** but might even endanger the positions of ***C. trilocularis*** and ***C. acutangulus.*** This much is certain, namely that if specimens be furnished in flower but not in fruit, the two chief jute plants can with difficulty be separately distinguished.

Races.

Recognisable Forms.

Colour of Stems.

Mr. Burkill in a report submitted on November 7, 1903, to the Director of Land Records and Agriculture, Bengal, as the result of his critical study of the races of this species, has pointed out that when grown in proximity to each other all these become crossed so freely that in a remarkably short time the progeny cannot be recognised as anything more than mongrels. The flowers are freely visited by bees and appear to be most readily cross-fertilised, though a certain percentage of self-pollination also occurs. Burkill remarks, moreover, that there are hardly any naked-eye features that one can seize on whereby to distinguish the races of jute, except the colour of the stems and leaf-stalks, the time of flowering and the height that the plants attain. The only one of these characters serviceable at thinning time is the first, and this in Burkill's opinion may have led to the development of the special red or green races that are characteristic of certain districts. N. G. Mukerji and R. S. Finlow, who wrote a note on explorations conducted by them in 1904, say there are three

Tarla.

Bombay.

Deswal.

chief forms of *C. capsularis*. These are the *Tarla*, the Bombay and the *Deswal*. The first grows the tallest (10 to 12 feet) while the last attains to only 7 feet, and the Bombay to 9 feet. The *tarla* stands waterlogging better, *i.e.* it does not get so "rooty" if late in the season there is an accumulation of 4 or 5 feet of water in the field. The Bombay and *deswal* both get rooty under these circumstances. The *deswal* comes to maturity early in July or even late in June, and has not, therefore, much time to get rooty, but it branches freely. The Bombay, though it gets rooty does not branch much, and bears very little fruit. The *tarla* is the form preferred where there is liability to much inundation.

Habitat.

Chinese.

Habitat.—Bretschneider (*l.c.* 441) observes that a species of *Corchorus* is grown to a large extent in the plain of Ning-po. In China this fibre is used in the manufacture of sacks and bags for holding rice and other grains. So again, he says, jute (*Corchorus sp.*) is the most important fibre plant of the plain of Tientsin. It grows to a great height. The *Board of Trade Journal* (Oct. 29, 1903) speaks of the exports of 40,000 cwt. of jute from Tientsin. The specimens in the Kew Herbarium show that the *Corchorus* of Tientsin is the present species. Further, Roxburgh tells us that a reddish-stemmed form of *C. capsularis* had been successfully acclimatised in Bengal, the seeds of which came from Canton. This, he adds, yields a better quality fibre than the *C. capsularis* of Bengal.

Eastern Bengal.

So far as India is concerned to-day, *C. capsularis* is grown mainly in Eastern and Northern Bengal and Assam, and thus in a country that possesses many strongly Chinese peculiarities: seen in the people who inhabit it, in their articles of food and nature of some of their social customs, as also in the climate and soil of their country (see **Bœhmeria nivea**, p. 148). If, therefore, one were pressed to give an opinion, based on botanical data, as to whether or not jute was indigenous to India, that position might have to be conceded for *C. olitorius*—the least important of the two jute plants, but very possibly would have to be refused for *C. capsularis*, unless an exception were made in favour of Eastern and Northern Bengal, a tract of India with strong Chinese characteristics. In fact at least one of the best varieties, *C. capsularis*, has already been indicated as derived from China, though in connection with the earliest published drawing of that species the author (Plukenet) speaks of it as the American plant with long leaves and striated sub-round fruits.

Herbarium Specimens.

I have in the *Dictionary* (*l.c.* 536) discussed the specimens of this species seen by me in the Calcutta Herbarium. It may be useful to give here some particulars of the examples in the Kew Herbarium. No specimen in either collection is stated by the contributor to have been found wild in India, in the Malaya, in China, or in Japan. With the exception of a specimen from Natal (of which little is known) there are no examples of this plant from Africa, Arabia or America. The following may be specially mentioned:—From *India*—Upper Assam (by Jenkins); Bengal; Sikkim Terai, a remarkable example collected by Hooker and which has long narrow linear, deeply and uniformly serrate leaves; other examples of the typical form from Moradabad; Saharanpur; Kanara, and Mysore. From *Ceylon*—a few sheets. Many examples from *China*, most of them stated to be cultivated and one accompanied with samples of the fibre and fragments of the textiles made of it, viz. that from Ningpo (Hosie's collection); Foochow (Carles); Kiu kiang (Shearer); Yangtsze-kiang (Faber); Hongkong (Champion, cultivated). [*Cf.* Hemsley, *Journ. Linn. Soc.* (*Bot.*), 1886, xxiii., 94.] From *Japan*—two samples, one said to be cultivated, the other no record. Lastly from *Perak*, *Tonkin* (Balansa's collection); *Sarawak* and the *Celebes*—fairly complete sets, but none of them stated to have been found in a wild condition.

Not Indigenous to India.

Not a few authors have, however, affirmed that this plant is wild in China, the Malaya and India. I repeat there are no botanical specimens either in the Calcutta or the Kew Herbaria to support the opinion that it is indigenous to India, and in my personal experience it nowhere exists there, even in a state of acclimatisation. It is a cultivated plant of a very restricted area, and one subject to greater racial modification than the next form.

India generally.

C. olitorius, *Linn.*, including *C. decemangularis*, *Roxb.*, *Fl. Ind.*, ii., 582; Camerarius, *Hort. Med.*, 1588, 47, f. 12; *Prosper Alpinus, De Pl. Ægypti*, 1592, 39 and t.; Parkinson, *Theat. Bot.*, 1640, 309 and fig.; Plukenet, *Alm. Bot.*, 1696, 17; *Phyt.*, t. 127, ff. 3, 4; Forskal, *Fl. Æygpt. Arab.*, 1775, 101; Lamarck, *Encycl. Bot.*, 1786, ii., 103, t. 478, f. 1; *Bot. Mag.*, 1828, iv.,

f. 2810 (but fruit a little too pointed); Richter, *Codex. Bot. Linn.*, 1840, 525 (shows that Linn. first included Pluk., t. 127, f. 3, under this species and subsequently placed it under *C. æstuans*, *Sp. Pl.*, 1762, 746; but Linn. cites in addition Browne, *Triumfetta*, in *Nat. Hist. Jam.*, 232, t. 25, f. 1—a plate that in my opinion is rather *C. acutangulus*); Martius, *Fl. Bras.*, 1842, xii., pt. iii., 126; Prain, *Beng. Plants*, i., 286; etc., etc.

A Weed of Cultivation.

The vernacular names usually given to this species cannot be accepted as separately distinguishing it, though *ban-pát* is its most general name—a circumstance indicative of its frequency as a weed of cultivation. So also the fibre of this form is perhaps that very generally designated as *desi pát* or *tosha*.

Edible Form.

Moreover the plant is (even in India) the edible species of authors, and it is just possible that it corresponds with the Jew's Mallow and even the *melochia* of the early writers. Mukerji (*Handbook Ind. Agri.*, 1901, 298) would, however, seem to think ***C. capsularis*** is the vegetable and ***C. olitorius*** the medicinal form. It is thus possible that the tender shoots of both species are eaten. The Indian names - *nálita* (a corruption of the Sanskrit *nadika*), *nutia*, *narich*, *sag*, etc.—may, however, be accepted as mainly denoting the present species.

Error committed.

It is, therefore, somewhat surprising that the plant figured by Rumphius as the *sag* of Bengal should have been ***C. capsularis.*** This was most probably a mistake due to his not having personally investigated the Bengal plant. The *Ganja sativa* of Rumphius (his cultivated species) is undoubtedly, however, ***C. capsularis***, while his *Ganja agrestis* (or the wild form) is not a species of ***Corchorus*** at all. It would thus seem fairly certain that Linnæus was in error when he identified the latter as ***C. olitorius***, and to this error very possibly is attributable the statement, made perhaps more emphatic than the facts justify, viz. that ***C. olitorius*** is indigenous to India. But it is curious that Rumphius should have regarded ***C. capsularis*** as the special cultivated form, since in Egypt, Africa, America and India, ***C. olitorius*** is the edible and hence the cultivated plant of most non-Indian authors. Sir William Jones while discussing the *śaná* (***Crotalaria juncea***) incidentally speaks of the "*Capsular Corchorus*," so that by 1795 the two forms may be assumed to have been accepted by Indian botanical authors as distinct.

Description.

The leaves of ***C. olitorius*** are usually glabrous, except on the petioles and veins of the undersurface; the flowers are seemingly larger than in ***C. capsularis***; the capsule is elongate, cylindrical, usually not materially tapered at either end, glabrous, smooth, beak long, straight, cells and valves generally four but five not uncommon.

African *versus* Indian.

It would seem that the fruits are longer, thicker and smoother in the African than in the Indian forms, though apparently the fruit is smooth when collected mature and warted when immature. Some of the African and Egyptian forms have the fruit tapered at both ends: this is not true of the Indian plant.

Habitat.

[illegible] Bardwan, Khulna, 24-Parganas, Hughli, etc., but it is met with here and there completely acclimatised on roadsides and margins of fields all over India and Burma.

Claim to bei Indigenous.

Its claim to being strictly speaking indigenous, however, rests on doubtful evidence. It is certainly more frequently and more widely met with in India than is ***C. capsularis.*** It seems also fairly certain that in India it is a much less variable plant than the "Capsular Corchorus."

Races.

But it may be said that while all the forms met with in the Indian jute area do not (on the botanical standard) amount to more than cultivated races, there are numerous allied forms met with in Africa, Egypt and America that perhaps deserve to be recognised as definite varieties. But on the other hand several plants described by botanists as species might very possibly be more accurately treated as varieties of the present. But it is hardly matter for surprise that a pot-herb, met with throughout the tropical regions of the globe, and which has existed at least for centuries under garden cultivation, should have assumed a multiplicity of varieties and races; in fact the comparative paucity of Indian forms is a significant circumstance. In India it is invariably found on high and dry land, hardly ever under the inundation indispensable with *C. capsularis*. It is admittedly inferior as a source of jute, and is never cultivated where *C. capsularis* is possible. But it occasionally grows taller than even some of the forms of *C. capsularis*, such as the *deswal*; it prefers sandy loams, and takes a longer time to come to maturity (September and October, the *deswal* season being July).

Pot-herb.

Inferior Jute.

Season.

Herbarium Specimens.

In the Kew Herbarium there are numerous interesting samples of this species the labels of which occasionally bear instructive notes, a few of which may be here quoted:—From *India*—Madras, cultivated in gardens; Mysore (Rottler's specimen has the note that paper is made from it in Bengal); Lower Bengal, many; Burma, Ava (Wall. herb.); Belgaum, Ritchie's, said to be eaten but not cultivated, though always found near cultivation; Moradabad; Amballa, in cornfields; Kumaon, up to 4,000 feet; Nepal; Simla, up to 4,000 feet in fields. Afghanistan, roadsides and fields; Sind, occasionally. From *China*—Yunnan. From *Ceylon*, up to 3,000 feet. From *Africa and Egypt*—Liberia (Sir H. H. Johnston contributes a plant with very large smooth fruits, and narrow, thick, and sharply serrate leaves); Angola; Senegambia; Sierra Leone, cultivated; Zambesi (vernacular name *terere* = eaten); Niger river, in fields; Kordofan, edges of fields; Khartoum; Lake Nyassa; Cross River, Old Calabar. From *Madagascar*. In the *West Indies*—Cuba and Jamaica, cultivated from Calcutta seed. From *Mauritius*, introduced before 1864, now a weed. From *Java, Philippines*, etc. From *Australia*—Alligator River (leaves very narrow), etc., etc.

CULTIVATION IN INDIA.

History.

History.—The history of the modern jute industry is exceedingly interesting and at the same time closely associated with the British rule in India. There can be little doubt jute fibre has been known in India from comparatively ancient times, but the confusion that existed, almost down to the middle of the 19th century, in the use of the words *san*, *bhanga*, *pát*, *goni*, *gania* (*gunny*), hemp, etc., renders it often a matter of supreme uncertainty what particular fibre may have been indicated by the majority of writers who use one or other of these names. It would seem more than probable that *san*-hemp (the fibre of **Crotalaria juncea**, see pp. 430–7) was better or earlier known to the ancient Hindus than were jute or even the true hemp (**Cannabis sativa**, see pp. 251–5). Moreover, it is almost safe to assume that for many centuries the names mentioned were used almost synonymously, just as in modern commerce there are perhaps a dozen widely different fibres all called hemp. Hence also the expression, frequently met with in Indian modern trade returns, of "hemp other than jute," which shows that jute was viewed as but a form of hemp that it had been found desirable to record under a separate heading. The first commercial mention of the word "jute" occurs apparently in the returns for 1828, and it seems fairly certain the vernacular name *pát* had by then been fixed as the equivalent of jute. In the Bengal Board of Trade, consultations for January 14, 1793, for example, we read of the continued efforts made to establish Indian hemp as a recognised trade fibre. This is reproduced by Robert Wissett (*Treatise on Hemp*, 1808, 23) and again in Milburn's *Oriental Commerce* (1813, i., 283; ii., 209–11). The returns quoted in the last-mentioned work are for the years 1786 to 1803. It is pointed out that there were various qualities of hemp such as "*sann*, *ghore-sann* and the *paut*," which last, as "it does not grow to the height of above 4 feet . . . is not a profitable article to the landholder." "The leaves and tender shoots are used as an article of food." The plant in question was in all probability *C. olitorius*. But, farther on, allusion is made to "*cooch-murden-paut* and *amleeah-paut*"; the former may have been *C. capsularis*, and the latter no doubt was ***Hibiscus cannabinus***. About the period indicated the East India Company made a great effort to discover a good substitute for Russian hemp, to be employed in the manufacture of ropes and sail canvas. This led to many practical and useful discoveries. Roxburgh wrote in the *Transactions of the Society of Arts* a paper on the culture, properties and comparative strength of hemp and other vegetable fibres, the growth of the East Indies (1804, xxii., 363–96; 1806, xxiv., 143–56). In a letter to the Court of Directors of the Company (dated 1795) he used the word "jute."

Confusion in Names.

Early Trade Records.

First Mention of Jute.

Gunny.

Col. Sir R. Temple has pointed out (*Ind. Antiq.*, 1901) that that name occurs, however, in the log of a voyage made in 1746. It has been suggested that the gardeners employed at the Botanic Gardens, Calcutta, were in Roxburgh's time, as they are to-day, natives of Orissa, and hence that the word "jute" may have been but an Anglicised form of their name for it—viz. *jhut.* But the incident mentioned by Temple carries the word back forty years before the date of the foundation of the Royal Botanic Gardens, though it is quite likely all the same that it came from *jhut.* The origin of the word *gunny* is curious. It no doubt comes direct from the Sanskrit *goni,* "a sack," but in modern usage, in the form of *ganja,* it denotes the narcotic of ***Cannabis sativa***, and has thus been transferred from a fibre to a resin. Whether or not *goni* exclusively denoted the sacking of the true hemp (***Cannabis sativa***) need hardly be discussed in this place. It was early applied to sacking made of ***Crotalaria*** fibre and even to that of ***Corchorus***, hence Rumphius (*l.c.* 212) gave the jute plant the name of *ganja* (*gania*) *sativa.*

Pliny's Pot-herb.

First Picture.

Molochine Cloth.

The early references to the jute plant down to the middle of the 18th century may be said to be very largely concerned with identifying the pot-herb which Pliny (79 A.D.) describes as being used by the Egyptians. Considerable uncertainty prevails as to its being the *melochia* (*melokyeh*) of the Arabs. Simon Januensis (1473), for example, speaks of the leaves as being hawked in the streets of Babylon. Rauwolf (1583) was apparently the first traveller who critically examined the *melochia,* which he found being cultivated on the banks of the Euphrates, and which he says was largely eaten by the Jews near Aleppo. Camerarius (*l.c.* 47) was perhaps the first botanist who figured it, and his engraving is an excellent representation of one of the African forms identical with or closely allied to ***C. olitorius***. It had been prepared by Gesner but never published, and he lays stress on the fact that it shows the bearded base of the leaf and the cylindrical fruit—characters which had not been previously made known. ***Corchorus***, as accepted by modern botanists, was thus in the sixteenth century definitely determined to be *melochia.* But although this pot-herb of the Arab writers and Eastern travellers (from perhaps 1000 A.D. onwards) was unquestionably an edible ***Corchorus***, it is fairly certain that the *molochine* cloths of Greek and Latin authors (Arrian, Pausanias, Pollux, Nævius, etc.) were not jute textiles. Yates (*Text. Antiq.*, 303-4 *et seq.*) is of opinion that the *molochine* cloths brought from India were made of ***Hibiscus*** fibre. In the *Periplus* the *molochina* were said to be procured from localities identified as Ujjain and Junnar. The fibre of the former locality could hardly have been other than ***Hibiscus cannabinus***, while the latter most probably was ***Crotalaria juncea***, if guessed at purely and simply on modern experience of the distribution of the fibrous plants of India.

Sackcloth.

"Gunned" Packages.

"Sackcloath Londre."

In the *Ain-i-Akbari* (1590, Jarrett, transl., ii., 123) mention is made of sackcloth (*tát*), but whether of jute, *san*-hemp, or even of the true hemp cannot be ascertained; but Jarrett, in a footnote, identifies it with jute and the district of Rangpur. That textile was, however, made at Ghoraghat in Eastern Bengal, and thus in the very heart of the jute country, so that it may perhaps be assumed to have been the jute textile in which, about the time in question, it is believed the poorer people were clad. For two centuries after the date of the *Ain* no mention is made of any fibre or textile that could with certainty be taken as having been jute, though all coarse textiles appear by that time at any rate to have been spoken of as *gunnies.* W. Foster, for example, has drawn my attention to a passage (in *Engl. Factories Ind.*, 340) of date Surat 1621 in which packages are spoken of as "gunned." This could not have been jute cloth, but more probably was a textile of ***Crotalaria*** or ***Hibiscus***, since even to the present time jute is not produced in the Bombay Presidency. Curiously enough the coarse textiles made in England, about the time here indicated, were characterised in Persia as "Sackcloath Londre" (Fryer, *New Acc. E. Ind. and Pers.*, 1672-81, 224), and it is thus even questionable how far the simple use of the word "sackcloath" or its vernacular equivalent "*tat*" can be accepted as denoting jute fibre. Frequent mention is made by Foster (*l.c.* 76) of "*gunny*" among the articles to be sent from Surat to Persia.

Rheede's Silence.

In this connection also it may be regarded as significant that Rheede (India's earliest scientific botanist) is silent regarding the species of ***Corchorus***, although both ***C. capsularis*** and ***C. olitorius*** have been repeatedly collected subsequent to his time on roadsides and as weeds of cultivation, not only in Rheede's special country—Malabar—but here and there throughout both Southern and Western India. On the other hand, Rumphius, as already pointed out, gives a most

Rumphius' Account.

Chinese Jute.

Purified by Lime.

instructive account and figure of **C. capsularis** (*Ganja sativa*). Its common name, he says, is *Sajor Bengala*, "either because it is plentiful in Bengal or because it is the chief pot-herb" of that country, where it is known as *padhac*. Presumably *padhac* may be a variant of the present-day name *pát*. But Rumphius adds that it was much cultivated in Bengal, Arakan and South China, from which last country the seeds had been obtained by Amboina *viâ* Butona. He does not say whether in Bengal it yielded a fibre as well as being a pot-herb, but of China he remarks, "Fine white thread is made from the bark which is stronger than cotton, but rather apt to curl up. It is used in the raw state or may be separated by aid of lime water, then bleached in the sun." The silence preserved by Rumphius regarding the Bengal fibre, and his having laid special stress on its being a Chinese fibre, are features of his remarks regarding **Corchorus** which, when viewed alongside of the statement of its being the chief *sag* or *saj* (pot-herb) of Bengal, are certainly very significant circumstances. All writers seem agreed, however, that if **C. capsularis** be not indigenous to Southern China, it has been known and cultivated in that country for many centuries—has, in fact, an antiquity far greater than can be shown for it in connection with any other country. Plukenet's description which identifies it with America must be dismissed as one of the numerous enigmas of the literature of jute, if it be not accepted as yet another of the many evidences of the close association of India and America accomplished by the Spaniards and the Portuguese.

Extended Production Deprecated.

Cheapest and most easily manufactured Fibre.

Homestead Industry.

Domestic Craft decreased.

Hand-loom Gunnies.

Early Production.—It is a somewhat curious circumstance that Buchanan-Hamilton, in the first decade of the 19th century (*Stat. Acc. Dinaj.*, 198–9), should have expressed the hope that jute (or, as he called it, *pát*) fibre should under no circumstances be allowed to divert the attention of the public until a fair trial had been made with *san*-hemp. At that time both Roxburgh and Hamilton were engaged in the search after useful substitutes for hemp, to be employed for the ropes and cordage of the Company's ships. For this purpose Hamilton deprecated an extended utilisation of jute. It was not, however, till 1833 that his account of the jute cultivation of Dinajpur was published, and he there mentions that large quantities of the cloth called *tat* or *chota* were being produced. With the enhancement of manufacturing enterprise in Europe came the demand for foreign food supplies. This necessitated an increasing provision of sacking and packing materials, which it was early recognised could be best met by an extended production of jute. In consequence, a foreign demand for this, the cheapest and most easily manufactured of all fibres, was created and responded to by the cultivators in Eastern and Northern Bengal. The production of gunny-bags thus rapidly became a recognised part of the Bengal peasant's work. By and by, however, European machinery began to compete with manual labour, and, as in all other parts of the world, in due time gained the day. Practically every homestead in the jute tracts may be seen to have a few bundles of jute suspended from a beam in the roof of the verandah. That amount of the fibre is annually spun into yarn and worked up, as required, into string and rope, or is woven into *gunny* cloth or bags. Year by year, however, this domestic craft has decreased, and it may safely be affirmed that the decline in hand-loom jute-weaving is far greater than of cotton-weaving. In fact, at the present day hand-loom gunnies have practically disappeared from the markets of the world, and yet so late as 1880–1 the returns of foreign exports from India had to be divided into two sections: (*a*) power-loom; and (*b*) hand-loom. But that the loss of the hand-loom industry has not impoverished the jute districts may be inferred from the fact that in no part of Bengal are the poor now clad in coarse jute sackcloth—all are able to procure cotton garments.

Area.

Area.—It is impossible to give exact particulars of the total area under

First Record.
1872-3 Estimate.
1902-3 Actual.
Prospects.
Present Area.
New Areas.

jute at the beginning of the 19th century. Hamilton estimated that there were approximately 30,000 acres under the crop in Dinajpur. At the present time that district possesses about three times that area; but what is far more to the point, it is one of the unimportant districts in jute production. Unfortunately early statistics do not exist for the important districts of Bengal. In 1872-3 Mr. Hem Chunder Kerr estimated that there were one million acres under the crop, distributed over an area of 37 millon acres, and further, that should the demand be doubled, the production of that amount would absorb only one-eighteenth of the available and suitable land. It has since been more than doubled. The total cultivated area of Bengal in 1902-3 was close on 60 million acres, with, in addition, something like 14 million acres returned as culturable waste. All Bengal land is of course not suitable for jute, but these figures nevertheless give a tangible conception of the possibilities of the future, or rather of the adjustments possible on a still further increased production of jute being called for and responded to. In 1903-4 the returns of Bengal jute cultivation manifested 2,275,050 acres (including 38,250 acres in Assam) as under the crop. This may be taken as 3½ per cent. of the cultivated area of the province. It gave a yield of 7,241,000 bales (of 400 lb.) valued at 12 crores of rupees. Similarly, in 1904-5, the area was estimated at 2,899,700 acres, and the yield at 7,400,000 bales; in 1905-6 at 3,181,600 acres, and the yield 8,381,000 bales. The final forecast for 1906, issued by the Department of Land Records and Agriculture, showed the total area for the two provinces of Bengal and Eastern Bengal and Assam to have been 3,482,900 acres and the outturn 8,843,000 bales, and the estimate for 1906-7 to be 3,883,200 acres and the outturn 9,127,400 bales. Of that estimate the district of Mymensingh was calculated to have had 847,100 acres; Rangpur 455,800 acres; Dacca 312,000 acres; Tippera 310,000 acres; and Bogra 200,000 acres; while Faridpur, Pabna, Dinajpur, Rajshahi, and Jalpaiguri had each from 120,000 to 150,000 acres. The balance was accounted for by some four districts that have usually from 20,000 to 60,000 acres each, and a like number of districts each with less than 10,000 acres under this fibre plant. Lastly it may be here added the portion of the jute area comprised within the province of Bengal proper was in 1906-7 estimated to be 931,100 acres, of which Purnea was supposed to have had 264,900 acres; Jessore 142,800 acres; Murshidábad 95,000 acres; Nadia 93,000 acres; 24-Parganas 86,000 acres; and Hughli 65,000 acres—all other districts much smaller areas. Within the past few years two new Indian areas of production have begun to attract attention, namely Assam (proper) and Nepal. From the lower valleys and terai of the last-mentioned, fibre is exported and conveyed into the United Provinces and Bengal. It has been ascertained that this is mainly *baboi* grass, for the use of the Lucknow paper-mills, but to some extent jute is also supplied and enters Bengal through the district of Purnea. The Assam production (say 90,000 bales—*i.e.* 330,000 cwt.) does not seem to have materially increased for some time past. The Nepal jute, though at present relatively unimportant, has manifested a distinct power of expansion. In 1899-1900 it was 70,389 maunds, valued at Rs. 2,80,341; in 1902-3 it had become 149,518 maunds, valued at Rs. 5,08,898; and in 1904-5, 205,114 maunds, valued at Rs. 9,01,154. At the same time it may be safely added that no indication has as yet been given that, should occasion arise, Bengal might not even now materially increase its jute

Future Expansion.

production. Complaints have been heard of the expansion not being as rapid as could be desired. If this be the case it seems possible there may be some other causes than the indifference of the cultivators. In fact with improved rail and river facilities of transport the expansions of the past stand every chance of being not only maintained but even enhanced materially.

Soil.

Controlling Influences.

Soil.—Jute seems to be capable of cultivation on almost any kind of soil. It is least successful and almost unprofitable, however, on laterite and open gravelly soils, and most productive on loamy soils or rich clays mixed with sand. As already observed, ***C. olitorius*** requires higher land than ***C. capsularis***, but there is something as yet unexplained that controls the production of these two forms of jute and restricts them to their respective areas. Speaking generally, the finest qualities of ***C. capsularis*** are produced on homestead lands (*suna*) such as that required for *aus*-rice, pulse and tobacco, which crops are accordingly rotated with the finer qualities of jute. The coarser and larger kinds are grown chiefly on *sali* lands, that is to say the *chars* or mudbanks and islands formed by the rivers, and on completely submerged (*bil*) lands or even salt-impregnated soils, such as those of the Sundribans, but most of such inferior lands are better suited for ***C. olitorius*** than for ***C. capsularis***. It has been said that the best quality of jute is obtained from loamy soils. Clay soils give the heaviest yield, but the plants of such soils do not ret uniformly. Sandy soils produce coarse fibre. Plants grown on inundation lands produce surface roots that injure the fibre of the portion of the stem from which they arise. Leather is disposed to think geographical and climatic influences are possibly of more value than the composition of the soil.

Clay Soils and Heavy Yield.
Sandy Soils and Coarse Fibre.
Inundation and Surface Roots.

New Areas.

NEW AREAS.—A hot damp climate, in which there is not too much actual rain, especially in the early part of the season, seems the most advantageous meteorological requirement. Both climates and soils apparently identical with those of the Gangetic and Brahmaputra valleys have on more than one occasion been pointed to as hopeful new Indian areas, but still failure has so far resulted from the efforts made to extend cultivation into these. Mr. R. S. Finlow (Jute specialist to the Government of Eastern Bengal and Assam, to whom reference has been made above) has published an account of a tour conducted with a view to investigate the possibility of extending the cultivation of jute in India to new areas. Bihar, he thinks, holds out the best prospects of success. But the efforts in this direction have passed beyond the experimental stage, as the crops obtained have been good and the area an expanding one. Outside Bengal, the climatic conditions in Madras he thought more favourable than in other parts of India. The Malabar coast, South Kanara, and the deltas of the three great rivers, the Godavari, Kistna and Kauveri, were ideal centres. Bombay was less favourably situated but the experiments with the irrigated fields of Sind would be looked to with interest, and it was possible that the irrigated districts of Poona, the most westerly portions of the Deccan, and the Karnátak, and the higher lands in the Konkan might be found suitable. Lastly, in the Central Provinces, experiments made at Nagpur had given indications of success and were well worth persevering with. [*Cf. Bull. Agri. Research, Inst. Pusa*, 1906, No. 3.] Jute has been and is being tried in America (Dodge, *Useful Fibre Plants of the World*, 1897, 125–33), in Mexico (see below under Trade), in Africa, Algeria, Formosa, etc., among many other countries, with but indifferent results. Of Persia, Lord Curzon (*Persia and the Persian Question*, 1892, ii., 497) says that it is cultivated and used for making sacks, but the amount of fibre available, he adds, is insufficient, hence a steady import from India takes place. Fresh efforts are, it is understood, being contemplated in the Congo valley and in the Gold Coast, and these may be successful if cheap labour with the required knowledge and indispensable perseverance can be ensured. The alarm recently expressed regarding commercial production of jute in Hongkong may possibly be explained through the supplies

Bihar.
Madras.
Bombay.
C. Prov.
Mexico.
Persia.
Congo.

Hongkong. China and Cochin-China.

of Tonkin and Annam being exported *viâ* Hongkong. But it may be added that perhaps the foreign areas of which India need have any serious anxiety are China and Cochin-China. [*Cf.* Sly, *Extension of Jute Cult.*, in *Agri. Journ. Ind.*, i., pt. iii., 251; Finlow, in *Rept. Agri. Dept. E. Beng. and Assam*, July 25, 1907, app. ii.]

Tillage. Seasons.

Preparation of Soil.—It may be stated that, when the crop is to be raised on low lands, where there is danger of flooding, ploughing commences earlier than on the high lands. The more clay in the soil, the more frequently is it ploughed before sowing. The preparation thus commences in November or December, or not till February or even March. The soil is generally ploughed from four to six times, the clods are broken and pulverised, and at the final ploughing the weeds collected, dried and burned.

Seed. Not Selected. Sowing Seasons. Thin Sowing preferable. Spacing 4 to 6 Inches.

Seed and Sowing.—It would appear that no special attention is paid either to the selection of superior fibre-yielding seed or to the attainment of stock specially suited to the fields on which it is to be raised. The cultivators, as a rule, neither buy nor sell seed, and there is consequently little or no exchange of stock. In the corner of a field a few plants are left to ripen seed, and the supply thus obtained is sown broadcast. The sowings, according to the position and nature of the soil, commence about the middle of March and extend to the end of June, but *bil* land is usually sown in February to March. About 8 lb. of seed to the acre is the amount generally employed. Broadcasted sowings would appear to be the rule, but Mukerji recommends drill sowings, the lines being 9 inches apart, thus allowing of wheel or bullock hoeing. Thin sowing gives better yield but coarser fibre. The spacing most approved is when the plants are 4 to 6 inches apart. Irregular branching shortens the length of the fibre. Long cultivation on the same soil results in the plants becoming much branched. For results of experiments in thin and thick sowing, consult the *Experimental Farm Report Sibpur* (1901–2).

Rotation. Recent Experiments. Conclusions.

Rotation.—Since passing to press the present review of information on the subject of jute, an instructive report has come to hand on certain experiments performed at the farms of Bardwan and Cuttack. This has been written by F. Smith (*Agri. Journ. Ind.*, 1907, ii., pt. ii., 140–60), and deals with the results obtained during the past three years in Bardwan and the past year in Cuttack. He tells us that the following experiments were carried out: (*a*) manure tests; (*b*) cutting at different stages; (*c*) variety experiments; (*d*) spacing experiments; (*e*) thick *versus* thin sowing in the production of seed; (*f*) drill *versus* broadcast sowing; and (*g*) rotation experiments with paddy. Space cannot now be made available to deal with the details exemplified, but it may be useful to furnish Smith's general conclusions (*l.c.* 160) regarding the rotation of jute with paddy:—

"1. On *aman* paddy land, both jute and paddy can be grown in rotation with each other on the same land in the same year.

For Bardwan.

"2. For the Bardwan district, the third week of April should see the jute sown to enable the jute crop to be harvested in the last week of July and the *aman* paddy to be transplanted in the first week of August. The land should be cultivated for eight to ten days between the harvesting of the jute and the transplanting of the *aman* paddy.

For Cuttack.

"3. For the Cuttack district, the jute seed should be sown in the last week of March and the jute crop harvested in the end of July.

"4. The jute seed-bed can be well prepared by eight ploughings with the ordinary country plough, and by three ladderings with the ordinary country ladder.

" 5. For paddy the land is well prepared with three or four ploughings with the ordinary country plough, and one or two ladderings.

Farmyard Manure.

" 6. An application of 100 maunds of cowdung per acre to the land before sowing jute, and a top-dressing of one or two maunds of saltpetre per acre to the paddy crop when the land is just moist (*i.e.* when the soil is beginning to dry), will be found very efficacious.

" 7. The *raiyat's* food-supply is not only assured, but the extra jute crop gives a handsome profit."

Weeding.

Hoeing and Weeding.—In about fifteen days after sowing the weeds should be uprooted and the unduly thick sowings counteracted by the less healthy plants being removed and the desired spacing secured. This is repeated three or four times at intervals of two or three days, the soil being at the same time loosened.

Manuring.

Silt.

Farmyard Manure.

Advantageous to prolong Growth.

Manuring.—Very little manure is given to jute, especially where silt deposits take place. In fact the superiority of certain districts over others is largely a consequence of the heavy annual deposit of silt. When available the cultivators employ farmyard manure at the rate of 150 maunds per acre (the maund = 82·3 lb.). It is freely admitted this produces fine glossy and strong fibre. In fact, conversely, seed of the finest stock when grown on poor soil, especially if not manured, yields very inferior fibre. Under such conditions the plants, moreover, flower early, and it is a maxim that whatever will prolong growth and retard flowering will improve the quality of the fibre. But there are practical difficulties : in many cases there are no carts available to carry manure to the fields, and no roads along which heavy loads could be conveyed. Bonemeal, castor-cake, saltpetre and superphosphates have all been tested at the Government farms, but cowdung gave by far the best result. For experiments in manuring jute at Bardwan and Cuttack, the reader should consult the account published by Smith.

Harvest.

Ripe when Flowers appear.

Late Harvest increases Weight but lowers Value.

Harvest.—The time for reaping the crop depends entirely on the date of sowing ; the season commences with the earliest crop about the end of June and extends to the beginning of October, the average season being thus from middle of August to end of September. The crop is considered as coming into season (as is the case with most fibres) whenever the flowers appear, and as past season when the fruits are all formed. The fibre from plants that have not flowered is weaker than from those in fruit ; the latter is coarse and wanting in gloss, through strong. Success lies in the mean between these extremes, namely when the plants are in full flower and beginning to set fruit. Late harvest gives a high weight, and advantage being taken of this fact might account to some extent for the complaints of deterioration, though it seems that avaricious buying, either from necessity or on purpose, has taught the cultivators that rejections formerly deemed worthless have now a distinct market value.

Yield.

Average Maunds.

Improved by High-class Cultivation.

Crop.—The average crop per acre is a little over 12 maunds, but the yield varies considerably, being as high as 36 in some localities and as low as 6 to 9 in others. It is probable, therefore, that 14 might be a safer figure to accept as the average, and it is one borne out by last year's officially recorded area and yield. The yield is much dependent, however, on the season and the class of cultivation pursued—hence the severe fluctuations in supply characteristic of the transactions in this fibre. It has been estimated that with high-class cultivation costing as much as Rs. 30 an acre (or Rs. 2 a maund) the net profit should be from Rs. 20 to Rs. 30 an acre or more, according to the prices ruling, but it is feared that the actual amount expended is very frequently much below that figure.

Diseases.

Diseases and Pests.—In a paper on the *Insect Pests of Jute,* Maxwell-Lefroy (*Agri. Journ. Ind.*, 1907, ii., pt. ii., 109–15; also *Memoirs Dept. Agri. Ind.*, 1907, i., 160, etc.) says that our knowledge of these pests, though not extensive, has been considerably enlarged and, while there was reason to believe that this crop, grown on a large scale, suffered little from pests, there is now abundant proof that this does not hold good for small areas of jute or for jute grown in new localities. He then proceeds to describe the insects hitherto recorded as pests, viz. the Indigo Caterpillar, the Jute Semi-looper, and the Jute Weevil.

Retting.

Sweet Stagnant Water.

Fermentation.

Stacking before Retting.

Removal of Leaves.

Dark Colour of Fibre.

Presence of Iron.

Red Stem.

Inferior Fibre.

Separation of Fibre.—The process pursued in Bengal may be described as one of simple and inexpensive *retting*. But it is modified here and there to such an extent as very possibly to originate, at least in some measure, the various qualities of fibre recognised in trade. Sweet water is essential and stagnant is preferable to running, presumably because in the latter the germs necessary for the decomposition of the tissue are not developed so copiously. The most general practice may be thus briefly described—the stems are cut near the ground, tied into bundles, and carried off to a tank or roadside pool of clear, not muddy water. The bundles are laid the one on the top of another, and if need be are weighted to cause all to be submerged. In that position they are left until the decomposition of the connecting tissue has been accomplished and the fibres liberated. The period required for this purpose depends upon the nature of the water, the kind of fibre, and the condition of the atmosphere. The germ concerned in the fermentation (corresponding with that for hemp and flax) does not appear to have been as yet studied in connection with jute, and it seems, therefore, probable that great improvements are possible in this direction. So far as present practice and experience go, the retting period may be said to vary from ten to twenty-five days, but is largely dependent on whether or not the bundles of stems have been stacked to allow of drying before being retted. It would seem to be the case that partly dried stems ret more expeditiously, and, moreover, the removal of the leaves during the drying process is believed to prevent the discoloration of the fibre. It would also appear that in some localities the stems are even left on the fields for three or four days, being covered up with leaves, weeds and earth. They are then shaken out, the tips removed and thrown away, tied into bundles and carried off to the retting-pools. The use of sods and mud to cause the bundles to sink into the retting water is doubtless a fruitful cause of the dark colour often seen in certain parcels of fibre. It is on this account that logs of timber are used as weights, when at all procurable. It has also been affirmed that the red colour, often seen in the fibre, is due to the retting water having contained iron, but by others this is held to be a peculiarity of the race of jute plant (*altapati*), the colour being possibly imparted from the decomposing red pulpy tissues of the stems and leaf-stalks or inherent in the fibre itself. Mukerji does not think that a red-stemmed plant need necessarily afford a red-coloured fibre. He may be right, but this point needs confirmation. In many of the experiments conducted by chemists it has been found that the fibre manifests a tendency to assume a red colour under certain reagents. And it is sometimes affirmed that the red-stemmed forms give inferior fibre to the green-stemmed. It is essential that the operator should visit the retting-tanks frequently in order to ascertain when the decomposition is complete. When this is the case the fibre is found to separate easily from the stem. But the exact period must not be exceeded, otherwise the fibre becomes rotten and useless.

Retting must not be prolonged.

Separation of Fibre.—The cultivator then proceeds to separate and clean the fibre. Standing up to his waist in the now fœtid water, he seizes a handful of stems and beats the thick ends of these with a mallet. This assists in the separation. He then strips one after the other from end to end, and thus withdraws the canes entire. Taking up a large bundle of these ribbons, he now lashes them on the surface of the water and draws them towards himself by a sharp jerking motion which causes the adhering particles of tissue to be brushed off. Lastly with a dexterous action he spreads out the handful of cleaned fibre on the surface and thus exposes the still adhering particles, which he picks off by hand. The water is finally wrung out, and the clean fibre thrown over a bamboo which has been fixed near by as a drying-rack. During the drying process (which lasts for two or three days) the fibre is also bleached in the sun.

Separation of Fibre.

Washing of Fibre.

There are numerous minor modifications of this operation that need not be here detailed. But Leather (*Agri. Ledg.*, 1896, No. 37, 384–9) has pointed out that in Serajganj district a modification of this process is in his opinion of special value. "A bundle," he says, "of about twenty stems is taken in the left hand and most of the adventitious root removed with the right hand. Then the man takes a small wooden "beater" about a foot long with a 6-inch handle and flat sides, and after striking the bottom ends of stems until they are all level, he beats the lower portion of the bundle so as to loosen the fibre, turning it in the left hand at the same time. He next breaks the bundle at about the centre, first one way, then the other. Then clasping it, still in the left hand, just above the point of fracture, he strikes at the stems, with the beater, just below the fracture in a downward sort of way, and this knocks the wood stem outwards, so that after a few sharp strokes, and a little violent agitation in the water up and down, he can take hold of the stems and pull them out from the fibre, leaving it almost free from wood" (*l.c.* 388). The subsequent cleaning is the same as that detailed above. In fact the only difference between the description given by Leather and that of all other writers appears to be the more liberal use of the mallet as a first operation. He does not make it sufficiently clear that the stems are retted before the special treatment he has described is begun, but that doubtless is the case. Were it affirmed that less retting was pursued where beating was practised, there might be an advantage in the Serajganj system, but this does not seem to be the case. Still, the method of treatment is said to be the cause of the superior quality of the fibre for which Serajganj is noted. Banerjei (*Agri. Cuttack*, 1893, 83–6) says that in Orissa the stalks are often beaten against a platform until the pith within is removed. But he adds, "this mode is not to be recommended as the pith sticks get broken and mixed up with the fibre, which itself gets knotted so that the whole fibre has to be repicked." Machinery has also been frequently suggested and tried, but the retted fibre, if carefully prepared, is held to be softer and better than the machine-separated. Moreover, the retting process costs only the labour it entails. It involves no expenditure of capital—an all-important consideration with poor cultivators. Primitive it may be, but the retting process is eminently suited to the people and

Liberal use of the Mallet.

Superiority of Serajganj Fibre.

Machinery.

Attributes of Good Fibre.

to the country, and is moreover quite sufficient for the majority of the purposes for which the fibre is required. On these and many other such considerations, machinery does not seem likely to come readily into use in Bengal. Colour, lustre, length, softness, uniformity and cleanliness are the attributes of superior jute.

Grading and Baling.

Trade Qualities.

Late Flowering advantageous.

Seed Selection.

Time available for Proper Treatment.

Grading, Baling and Qualities, etc.—The produce is gathered together at various local centres: is sorted, packed and pressed for shipment. The sorting resolves itself into "cuttings," which consist of the woody and hard ends; "rejections," the lowest quality of fibre; and "jute" proper. But of jute there are trade qualities, denoted for the most part by the traders' marks more than by any special properties. These are chiefly characterised by colour, glossiness and softness. It is generally held that late flowering forms (*e.g.* those flowering in September) give finer and stronger fibres than the early races (those that flower about July), but the figures of yield that have been published would seem to point to environment exercising a powerful influence. It would appear, as Mr. Burkill has pointed out, that there is a tendency for jute to become early in the northern and late in the southern districts. This tendency, if confirmed, should be seized upon as one of value in seed-selecting. But the late flowering forms of one district do not apparently yield as much as the early flowering forms of another. Whilst that may be so, within any one district, the late forms are distinctly superior to the early ones. The variation in prices obtained is remarkable. Some of the forms of ***C. olitorius*** yield as much and fetch as high prices as some of the forms of ***C. capsularis.*** But when all is said there is a distinct advantage in the late forms, namely that the cultivators are then free to devote the required time for harvesting operations.

Uttariya.
Deswál.
Desi.
Deora.
Narainganji.
Serajganji.

Local Influences.

According to the reports currently issued, the finest grade is said to be the "*Uttariya*," which is strong, long and easily spun, brilliant in colour and of fine texture. In point of softness, however, it does not compare with "*Deswál*," the next most valuable grade. The quality classed as "*Desi*" (*Daisee*) is that most generally used in the gunny trade, and "*Deora*" (*Dourah*) in rope manufacture. Other qualities that may be specially mentioned are *Narainganji*, an excellent fibre, being long and soft, and the *Serajganji*, which comes from Pabna and Maimensingh. The geographic value is one, therefore, that demands close study. Prain, referring apparently to this subject, observes that a strain natural to or acclimatised in a particular district gives better results in that district than any freshly imported seed. At present there are districts that would seem to produce very much better jute than others even when the same seed is used and identical methods of treatment are pursued. The bales of jute consist of 400 lb., and are made up at the jute presses ready for export.

Prices.

Prices.—These are subject to very considerable fluctuations, as may be seen from the following prices ruling in Calcutta during January for the years 1900–1906:—

	1900. Rs.	1901. Rs.	1902. Rs.	1903. Rs.	1904. Rs.	1905. Rs.	1906. Rs.
Finest quality jute bales ..	35–8	34	32–8	37	36	41	52
Ordinary	32–8	30	28	33	31–8	40	47

Deterioration.

Deterioration of Fibre.—Much has been heard recently of the supposed deterioration of the fibre, though the subject is by no means a new one. It was discussed by Mr. Hem Chunder Kerr thirty years ago. The conclusion he arrived at closely corresponds with the particulars adduced

Scapegoat.

Brisk Demand and Careless Preparation.

Trade Qualities and Racial Forms.

No Deterioration attributed to the Cultivators.

Sports, not Varieties.

to-day. The cry of deterioration, as already hinted at, is largely, in fact, a scapegoat. Kerr remarked : " I believe I am justified in inferring that in proportion to the increase of the cultivation, the quantity of medium and inferior jute has been greater season after season. When the demand is great and the price high, as they have been for some time, people find a ready market for whatever they can produce, and naturally become careless ; whereas a glutted market leads to the rejection of inferior articles, and consequently cultivators are driven to the necessity of care in improving the quality of their goods." There would seem very little more to be said to-day on this subject except to make the commonplace observation (true of all branches of trade) that, whenever an attempt is made to "corner" a particular article, a rise of price must be closely accompanied by a fall in quality. Some few years ago (1887–8) my attention was specially directed to the subject of jute deterioration, and I accordingly took steps to have samples of the jute plant collected from all the districts of India where the plant was grown for its fibre. These came to hand during 1901–3, and may be now regarded as fairly complete. My object was primarily to discover if the recognised trade qualities could be traced to racial forms of the plant, or to climatic and soil conditions, or to methods of separation and drying of the fibre. It seemed probable there were two explanations of deterioration, assuming for the moment that the trade is correct in affirming deterioration, viz. (*a*) substitution of a prolific though poor stock plant, and (*b*) actual deterioration through exhaustion of soil. Since my departure from India many experiments and investigations have been continued by the Inspector-General of Agriculture, by the Superintendent of the Royal Botanic Gardens, by the Agricultural Chemist, by the Director of Agriculture, Bengal, and by the Reporter on Economic Products, in co-operation with the Committee of the Baled Jute Association. There have been brought together in consequence an extensive series of botanical specimens, of fibres, of soils on which the plant is grown and of waters used in retting, and these have all been critically examined and analysed, with the result that no direct confirmation has been obtained of a deterioration attributable to the cultivators. Moreover, the existence of botanical varieties under ***C. capsularis*** and ***C. olitorius*** has also been denied: the distinctive features based on colour of stems, etc. (upheld by agriculturists) have been viewed as alone justifying their acceptance as crosses, sports or races, not varieties. In passing it may be here repeated that Roxburgh says the reddish-stemmed forms of ***C. capsularis*** were imported from Canton, and then gave a superior fibre to the Bengal forms of that plant.

Fibre Deliberately damped.

Nothing could be more Injurious.

A feature of considerable importance in the controversy of deterioration has been established, namely that over and above occasional flooding of the markets with waste (that formerly would have been regarded as having no market value), the fibre is often nowadays deliberately damped in order to increase its weight. This would seem to be done by the middlemen (*beparis*), and not by the cultivators. N. G. Mukerji and R. S. Finlow, in a joint note on a tour of inspection, say " the *raiyat* produced good dry jute, but the article never reached Calcutta or Dundee as it was produced. The *bepari* would not buy damp jute." Nothing could be more injurious ; for, once dried, if subsequently moistened, the fibre rapidly loses both strength and colour and has its value thus materially lowered, besides necessitating its having to be opened out and dried before it can be baled with any

Legislation needed.

safety. It has been reported that the traders often add as much as 20 per cent. to the normal moisture of good clean fibre, as also a large quantity of sand, and thus are able to sell at less than they purchased, and still make a good profit. It has been urged by the Committee of the Baled Jute Association that so serious has this practice become that it would be advantageous to have a law passed that would penalise the sale of jute containing more than an accepted percentage of moisture. This matter was discussed at a meeting of the Bengal Chamber of Commerce, and it is understood steps are being taken that may result in the passing of a Bengal Jute Frauds Act.

The cumbrous nature of the channel of jute sales and the difficulties that exist in checking this criminal moistening of the fibre, may be learned from the following extract from a note on Fraudulent Watering by D. N. Mookerji :—

The Middlemen (*Beparis* and *Mahajans*).

Contracts made by Secret Symbols.

Brokerage.

"Between the *raiyats* at one end and the home market at the other there are the following middlemen :—*beparis* or dealers, *mahajans* or *aratdars*, buyers, balers, and shippers. Sometimes the last three functions are combined by the same firm that bale and ship off at Calcutta what their agents buy in the country. But the business at Serajganj may be said to be practically in the hands of the *mahajans* or brokers. They are well-to-do people, being mostly Marwaris. They advance money to the *beparis* or sellers, the condition being that the latter must bring to the *mahajans* all the jute they can get from the *raiyats*. The money is not realised from season to season, but is allowed to be in the hands of the *beparis*, one *bepari* sometimes having an advance of Rs. 5,000 or Rs. 10,000, and occasionally no less than Rs. 20,000. When the jute is brought to the *mahajan* he settles the price with the buyer secretly, the *bepari* having nothing to do with it and often not knowing at all what his jute sells for. He has only a general idea of the state of the market from the price other *beparis* receive for their jute. I witnessed, on several occasions, the way the price is settled between the *mahajan* and the buyer. The *mahajan* throws a corner of his *dhuti* over the hand of Mr. X. and makes a sign on his palm. The latter exclaims in surprise it is far too high and he cannot possibly pay more than so much, making an answering sign on the palm of the *mahajan*, still under the *dhuti*. After some haggling the negotiations terminate. The *mahajan* now at once settles with the *bepari*, who goes home with his money, he (the *mahajan*) being paid by the buyer a few weeks (generally three weeks) later. The *mahajan* gets a brokerage of 2 to 4 annas per maund, but over and above this we may be sure he leaves a margin between what he pays the *bepari* and what he himself gets from the buyers. Plainly he is entitled to some discount for the ready cash he pays in advance, but the rate might be definitely settled, and the transaction might be aboveboard. The price of jute is subject to violent fluctuations. Probably there is no other article the price of which varies so much in the course of a few days in the same season. Both the buyers and the *mahajans* have daily wires from all the important jute marts, telling them of the state of the market, but the information is carefully kept to themselves. It might be an advantage to have some agency for making it public. At Chandpur there are no *mahajans*, but the *beparis* deal directly with the buyers. The *raiyats* also to some extent sell their own jute to the purchasing firms, without the intervention even of the *beparis*." This remarkable story illustrates but one aspect, though a striking one, of the jute market.

[*Cf. Offic. Papers on Jute*, 1901-3; *Exp. Farm Rept. Sibpur, Beng.*, 1901-2, 13-4 (testing question of thick *versus* thin sowing); *Exp. Farm Rept. Bardwan*, 1901-2, 5; 1906-7, 21-33; *Bengal Admin. Rept.*, 1901-2, 17-20; *Ann. Rept. Dept. Agri. Beng.*, 1902-3, 2; 1903-4, 3; *Select. Papers, Inquiry. Jute Deterior.*, 1903-4; Trom de Haas, *Jute-Cultuur.*, *Batavia*, 1904; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 81-2.]

THE JUTE FIBRE AND JUTE MANUFACTURES.

Industrial Properties.

Industrial Properties.—Jute is a bast fibre. As found in commerce it consists of fibro-vascular bundles. These contain six to twenty ultimate fibres firmly coherent along their contiguous walls. The ultimate fibres are of the normal fusiform type and 1·5 to 3 mm. in length. In section they are seen to be thick-walled and polygonal. Jute is, moreover, an aggregate fibre and consists chemically of two substances, cellulose and non-cellulose. Cotton is pure cellulose, a substance that withstands very considerably the action of heat and moisture, and is even little affected by the ordinary chemical agents employed in the treatment of textiles. Jute, on the other hand, is highly susceptible, and is readily acted on by water and by even feeble chemical agents. It is the type of the fibres now spoken of as consisting of lignified-cellulose or, as it has been called, bastose. Dunstan (*Imp. Inst. Tech. Repts.*, 1903, 60-8), while contrasting pure cellulose with ligno-cellulose, says the most generally accepted view is to regard the latter as resulting "from the overlaying of normal cellulose by non-cellulose matters." He then explains that this overlaying weakens the cellulose. Another theory, however, is that ligno-cellulose is not encrusted cellulose but a distinct compound. Cross and Bevan (*Journ. Chem. Soc.*, 1889) were the first authorities to study jute critically. Their experiments and conclusions are too technical to be fully discussed here, but it may be said that they resulted in certain practical experiments having been conducted in India with a view to ascertain:—(*a*) the stage of growth at which the fibre was in its best condition, and (*b*) to discover whether by chemical treatment it was possible to ward off the tendency possessed by the fibre for a continuance of the retting, or rather rotting, process within the bales. It was admitted freely that the fibre as produced by the cultivator was very much superior to the same when delivered at the factory, more especially if it had passed through the damp heat to which it is unavoidably subjected in the hold of a ship during the voyage from India to Europe or America. It was felt, in other words, that if the fibre could be put through some simple chemical process, the effect of which would be to protect it against incipient fermentation, much would thereby be accomplished towards placing jute on a more certain and higher platform in the textile world than it at present occupies. It was, in fact, just possible some such treatment might even improve the quality as well as the durability of the fibre, without adding materially to its cost of production. Unfortunately, however, the treatment recommended proved unavailing, and Dunstan was thereby led to affirm that "the logical conclusion is, that attempts at special treatment of the fibre in India, before being supplied to the jute mills, or before shipment, are not to be advocated. The most hopeful directions for further experimental inquiry are these:—(1) of improving the stock by selection, and (2) of determining the most suitable time for reaping, the object being to secure that the fibre is cut at the best time."

Readily acted on by Water.

Chemical Theories.

Practical Tests.

Chemical Treatment.

Not approved.

From the brief account already given, it may have been discovered that for some years past the scientific officers of the Government of India

Improvements possible.

Fraudulent Increase of Weight.

have been studying the plant botanically, chemically and agriculturally, so that it is just possible improvements may yet be effected that will give a greatly extended interest to the fibre. Meantime a destructive tendency seems to have been established within the trade, namely fraudulent sprinkling of the cleaned fibre with water and sand in order to increase its weight. *And it may well be said that* if an enhanced price was the only consequence of this practice, the matter might not be more serious and vexatious than would be involved through having to impose rules of "refraction," but unfortunately the watering directly facilitates the injurious tendencies of the fibre, so that the commodity not only requires to be dried and rebaled before it can be shipped, but may have been seriously injured if not utterly ruined. In the opinion of some of the best-informed persons, this new phase is so serious as to threaten the very existence of the industry. The merchants and manufacturers are helpless.

Machinery.

Inundated Tracts.

Personal Advantage.

It cannot be said that the last word has been uttered in favour of machinery as a process of jute-fibre separation. If the weakening consequences of retting could be removed, that alone might prove of much value. No experiments of a satisfactory nature have as yet been undertaken with mechanical methods of jute production. But it is quite true, as often urged, that the Indian *raiyat* is too poor to purchase machinery, and that the inundated tracts of jute cultivation are not the most hopeful localities in which to anticipate the establishment of a complex mechanical and technical industry. Still, if by a mechanical or chemical process a greatly improved fibre were secured, the possibilities might be considerable. The Natives of India have by no means shown themselves averse to material departures from their time-honoured systems, whenever personal advantage is involved. But this has to be fully demonstrated before they will advance into new phases of old industries.

Manipulation.

Batching.

Spinning.

Purposes.

Batching and Spinning.—An important feature of jute fabrication is the fact that in an initial stage it is crushed by special machinery, and sprinkled the while with water and oil—"batching," as this is called. This lessens the harshness and brittleness of the fibre and thus prepares it for spinning. In the *Anglo-Indian Review* (Oct. 1903) there will be found an instructive article on the Indian Jute Industry, from which the following may be abstracted :—"The three main purposes for which jute is used are :—(*a*) for making cloth of different qualities, ranging from substitutes for silk to shirtings, curtains, carpets, or gunnies ; (*b*) for paper, which is chiefly prepared from the "rejections" and "cuttings" ; and (*c*) for cordage, which is made from the coarser and stronger qualities. The methods employed in spinning are in the main identical with those used in dealing with the heavy manufactures of flax, the fibre being either hackled or submitted to the breaker and the finishing card, thence passing through the roving frame on to the spinning frame in the ordinary way, though in certain very coarse yarns the material is spun direct on the roving frame."

Lime used in China.

In this connection it may be explained that in China, it would seem, lime is largely used in certain stages of the separation and cleaning of jute. No one appears to have described, with any degree of care, the method pursued, so that I am unable to furnish the particulars that would likely prove suggestive to the Indian cultivator and manufacturer. The subject is, in fact, alluded to here very largely in the hope that the admission of defective knowledge may call forth a fuller account

Chinese Jute.

than we at present possess. It may be mentioned, however, that there are samples of jute cloth from China, in the Kew Herbarium, that seem so different from the Indian article that they might be mistaken for linen. These, it is stated, have been treated with lime-water, but whether as an after-bleaching process or during the retting has not transpired. The fibre seems, moreover, to have been spun into much higher counts than the twenties customary in Indian high-class jute textiles; accordingly it appears finer and more beautiful than in the Indian fabrics. Every aspect, therefore, of the Chinese and Cochin-Chinese jute production and manufacture are well worthy of careful consideration by those interested in the Indian industry.

Jute Mills.

First Exports.

Dundee made Fresh Effort.

Bleaching and Dyeing.

Indian Jute Mills.—In 1820 jute fibre was first experimented with by Europeans, the result being a most unfavourable opinion—so much so that the brokers were for some years subsequently required to give a guarantee that sales of fibre effected by them were free from adulteration with jute. In 1828, 364 cwt. of raw jute, valued at Rs. 620, were exported to Europe. The manufacture of gunny bags and cloth was at that time entirely in the hands of the Bengal peasants, but the traffic could not have been extensive since there is no record of exports. In 1832 an enterprising Dundee manufacturer experimented once more with the fibre, with the result that he was able to show that it might be used as a substitute for hemp. This success, it is understood, was largely a consequence of the use of whale-oil to soften the fibre. From that date, however, jute gained rapidly in popular favour. It was recognised as capable of the most minute separation or subdivision, but only within the past few years has this fact been utilised for the finer textile purposes. In time the difficulties of bleaching and dyeing the fibre disappeared, and the success of jute was assured. Thus was the foundation laid of the manufacturing enterprise both of Calcutta and Dundee.

Large Exports at once organised.

First Indian Mills.

Capital.

With the establishment of the jute mills in Dundee, a large export traffic in the raw fibre from Calcutta sprang into existence. But until the year 1854 little or no effort was made to organise mills in India or to improve the village hand-loom production, with a view to participation in the new demand of foreign countries for jute sacking. In that year, however, the Ishera Yarn Mills Company was established in Serampore. Three years later the company known as the Barnagore Jute Mills was formed, and in 1863-4 the Gouripore Jute Factory was built. Soon thereafter factories sprang up rapidly in and around Calcutta, until the banks of the Hughli literally teemed with their smoking chimneys. In 1891-2 there were 26 jute mills with a capital of Rs. 1,37,50,000 plus £1,757,000. These had 8,295 looms, 172,696 spindles, and gave employment to 65,423 persons. Ten years later (1901-2) there were 36 mills with a capital of Rs. 4,35,08,040 plus £1,741,358. These possessed 16,119 looms, 331,382 spindles, and gave employment to 114,795 persons. In 1903-4 there were 38 mills with a capital of Rs. 4,03,55,000, plus a sterling capital of £2,263,358. These possessed 18,406 looms, 376,718 spindles, and gave employment to 123,869 persons. In 1904-5 there were 38 mills, capital Rs. 4,66,80,000 plus £2,283,358, possessing 19,991 looms, 409,170 spindles, and employing 133,162 persons. It will thus be observed that while the English capital of the Bengal jute industry has not progressed very greatly, the Indian has advanced from a valuation of 1¼ crores to over 4 crores of rupees. I am unable to discover returns

Capital Invested.

of a later date than 1904–5, but the following statement from the *Moral and Material Progress and Condition of India* (1905–6, 177) may be given :—"The number of jute mills in 1905–6 was 39, containing about 22,000 looms and 453,000 spindles, and employing a daily average of nearly 145,000 persons." "The paid-up capital employed by these mills, excluding one which had not reported its capital, was £7,142,000, including debentures issued ; of which nearly 2¾ millions are sterling capital. About £600,000 was added to the paid-up capital and debentures during the year under report."

Dundee *versus* Calcutta.

In the *Dictionary* a calculation will be found as to the comparative value of the Indian and the European operative. Briefly this may be expressed as 3 to 7. That is to say it requires 7 Indian operatives to work one loom as against 3 in a Scotch factory. It is believed that estimate will be found fairly correct. The late Sir John Leng, M.P. for Dundee, paid a visit to India in 1896 and contributed to the *Dundee Advertiser* a series of articles, one of the chief purports of which was to exhibit the relative advantages of Dundee and Calcutta. The reader will find these highly instructive, and as the articles in question appeared subsequently in pamphlet form, they should not be difficult to procure. It has been claimed that the Indian Factory Act is more favourable to our manufactures than is the English Act to Dundee. This contention has, however, been replied to by the Indian Jute Manufacturers' Association, which among many disadvantages claimed that in India from 25 to 35 per cent. more hands had to be employed than in Europe with mills turning out the same goods. The difficulty in all such calculations is to express the two sets of mills on the exact same standard, but it seems probable the claim just mentioned errs on the side of under rather than overstating its case.

Jute Presses.

Jute Presses.—In addition to jute mills the presses are important, and are concerned with the foreign trade in raw jute. In 1896–7 there were 88 presses that gave employment to 9,890 persons ; in 1900–1 these had expanded to 133 presses and 20,387 persons; in 1903–4 there were 156 presses and 23,736 employees ; and in 1904–5, 163 presses and 23,991 employees.

Home Consumption.

Total Crop.

Industrial Prosperity.

TRADE IN JUTE. Consumption of Jute and Value of the Industry.—It will be recalled that in 1828 the recorded exports were 364 cwt. It has already been stated that the Indian area in 1905–6 under this fibre was 3¼ million acres and the produce 8¼ million bales of 400 lb. each, or say 29½ million cwt. The estimates of the crop of 1906 are 3,336,400 acres and 8,736,220 bales. The exports of raw jute from India in 1905–6 were 14,480,407 cwt., valued at Rs. 17,12,56,641. This would represent about 48 per cent. of the total crop of that year, so that there would have remained in round figures 52 per cent. of the production as available for the Indian mills. In previous years, however, the quantity remaining in the country was ordinarily a little less than the production. Thus, as with cotton, so with jute, the Indian mills and handlooms, etc., have hitherto used up a little less than half the quantity produced ; but as a mark of industrial prosperity, let it be added that India's share is steadily increasing. Speaking of jute, therefore, if we accept a ratio based on the declared value shown at the Custom House for the jute exported, as applicable to the share that remains in the country, a conception of the total value of the crop may be obtained that would not be seriously inaccurate. In round figures, and to err on the side of under rather than

Value of Jute to Bengal Agriculture.

overstating the case, a value of Rs. 33,00,00,000, or say £22,000,000, was the contribution of European manufacturing enterprise, paid in 1905-6 to the agriculturists and traders of Bengal for raw jute.

Exports: Raw.

Receiving Countries.

Exports.—Of the exports of Raw Jute in 1905-6, 42 per cent. was conveyed to the United Kingdom; 19 per cent. to Germany; 14 per cent. to the United States; and 10 per cent. to France. In 1906-7 the actual figures in value were Rs. 26,83,86,810. Of the supply drawn to the United Kingdom, a fair amount is reshipped to the Continent—France being the chief recipient, while from the jute secured by the Indian mills, goods are manufactured of which a very large portion is annually exported as jute manufactures and the balance used up in the local markets. In 1906-7 these foreign exports were valued at Rs. 15,68,34,740. The wages and profits of this manufacture, to a large extent, are realised in Calcutta, and the mills gave in 1905-6 an average daily employment to 145,000 persons. The exported manufactures ordinarily represent approximately about two-thirds of the turnover. An estimate, for example, was made of the total value of the manufactures of the Indian mills during 1901-2, and the figure arrived at was 1,150 lakhs of rupees. The exports to foreign countries were that year Rs. 8,71,14,174, which thus left a balance of manufactures to meet the Indian market of Rs. 2,78,85,826. By way of contrast with these stupendous attainments it may be mentioned that some thirty years ago the foreign exports of jute manufactures were returned as valued at Rs. 71,94,776 (or £479,651).

Manufactures.

Value of Local Manufactures.

Sudden Growth.

Cloth *versus* Bags.

Recently the exports of jute cloth have been progressing in a higher ratio than those of bags, which is possibly to some extent the outcome of the cloth finding new purchasers, such as those of the linoleum manufacturers (see **Carthamus**, p. 282). The United States of America ordinarily take over 70 per cent. of the jute CLOTH made in India (479,387,950 yards out of 696,067,945 in 1906-7). Australia is the largest single purchasing country for BAGS, though within recent years it has been followed closely by the Argentine Republic. The total exports in 1906-7 were 257,683,115 bags, of which 37,002,300 went to Australia and 22,890,500 to Chili, with 33,882,485 to the United Kingdom.

Complete Statement.

This brief review of some of the more striking and practical aspects of the jute trade may now be fittingly concluded by the following statistical abstract of the total value of the traffic :—

Statement of Jute Trade.

EXPORTS.	1876-7.	1886-7.	1896-7.	1904-5.	1905-6.	1906-7.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Raw Jute ..	2,63,66,466	4,86,98,146	10,55,05,775	11,96,56,462	17,12,56,641	26,83,86,810
Twist and Yarn	Nil	Nil	4,63,990	35,709	44,158	3,27,563
Bags	64,64,808	1,05,12,224	3,51,87,807	4,75,54,310	6,07,83,908	7,34,72,260
Cloth	6,94,643	9,80,741	1,63,03,568	5,11,60,958	6,30,50,100	8,25,87,265
All Others ..	35,325	25,612	1,83,938	6,37,699	6,01,678	7,75,215
TOTAL EXPORTS	3,35,61,242	6,02,16,723	15,76,45,078	21,90,45,138	29,57,36,485	42,55,49,113

IMPORTS.	1876-7.	1886-7.	1896-7.	1904-5.	1905-6.	1906-7.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Raw Jute ..	179	7,007	3	840	926	501
Twist, Yarn, etc.	75	20,170	97,268	1,04,570	1,21,382	1,20,812
Cloth	9,221	68,225	2,12,531	4,12,947	4,60,254	4,49,704
Bags	35,872	2,51,801	4,27,790	6,45,585	7,65,682	7,49,542
TOTAL IMPORTS	45,347	3,47,203	7,37,592	11,63,942	13,48,244	13,20,559

To the figures of exports would have to be added the value of the fibre and manufactures consumed locally. It has been already explained that about one-third the produce of the mills is used up in India itself. It may be a surprise, however, to learn that India actually imports raw jute. It comes from Ceylon, and is received by Bengal. Of the manufactured jute the cloth comes from the United Kingdom, Hongkong, the Straits Settlements and Italy. Then again, under the heading of jute canvas Bombay imports a fair amount annually from the United Kingdom.

Extreme Cheapness.

Labour.

Price.

Export Duty.

Economic Aspects.—But prosperous though the jute trade is, and although it is perhaps the most valuable single crop—other than food crops—possessed by the people of Bengal, it cannot be upheld that the extreme cheapness of the fibre has been an unmixed blessing. It seems highly likely that its absurdly low price has enabled the manufacturers in their competition for weavers to raise the wages of the operatives until it has come about that they have rendered it all but impossible for other textile industries to exist in the Lower Provinces. And what is more surprising still is that in spite of high wages a sufficiency of desirable labour is not attainable. It has been estimated that jute can be produced at Rs. 2 a maund, and that with freight and agency charges it might be landed at Calcutta at Rs. 3 a maund, or Rs. 82 a ton (or say £5 10*s*. a ton overhead, or for the first marks say at £7 10*s*. per ton f.o.b.). The London quotations of Messrs. Ide & Christie, July 15, 1907, are, spot values—Good White to best, £27 to £34; Good, £22 to £24; Medium, £19 to £21; Common, £15 to £17; Rejections, £10 to £13; and Cuttings, £6 to £8. In view of this remarkable state of affairs it has been recently suggested that an export duty might easily enough be placed on jute without doing any harm to the industry, since Bengal enjoys an absolute monopoly and no other fibre can be produced anything like so cheaply.

Fraudulent Watering.

The Bengal Chamber of Commerce issued on March 12, 1897, a flyleaf on procedure rules for jute arbitrations between mills and sellers. These, it is believed, are still in force and are ordinarily recognised; but, as already intimated, a bill to prevent fraudulent watering seems earnestly desired by all those most interested in the trade.

Burlaps.

Vera Cruz Mills.

In the *Dictionary* and other publications will be found details of the classes of goods produced both in India and Europe. In the Consular Reports (more especially of the United States) jute-sacking usually appears under the name "Burlaps," the traffic in which is very considerable. Of Vera Cruz (*Dipl. and Cons. Rept.*, Sept. 1905, No. 3,503, 20), mention is made of two highly successful jute mills that hitherto have depended for their supply of raw jute on supplies drawn from Calcutta. They manufacture the bags used for coffee, sugar, grain and minerals. Recently attempts have been made to grow the fibre locally, and high expectations are held of ultimate success in that direction. It is somewhat significant that in the Indian trade statistics no mention is made of exports to Mexico, though the United States last year received nearly 2 million cwt.

One-sided Traffic.

Speaking generally it would seem that the Indian mills run for the inferior, and the European for the superior goods for which jute has been found suitable. It is often affirmed that the Indian mills would perhaps hold a more secure position against the future were they less exclusively concerned in the *gunny* and sackcloth trades. It has, moreover, been often pointed out that a rise or fall in the price of raw jute

Forward Contracts.

is rarely immediately followed by a corresponding movement in the prices of the manufactures. This is largely a consequence of the stocks that are held and the habit of accepting forward contracts at even lower rates than the ruling prices for the time being.

D.E.P., ii., 567-9. Coriander.

CORIANDRUM SATIVUM, *Linn.; Fl. Br. Ind.*, ii., 717; Duthie and Fuller, *Field and Garden Crops*, pt. iii., 40, pl. lxxvi.; Duthie, *Fl. Upper Gang. Plain*, i., 397; Cooke, *Fl. Pres. Bomb.*, i., 573; UMBELLIFERÆ. Coriander, *dhanya, dhaniá, kothamira, khotbir, kuzbarah, kushniz, kotamalli, havija, nau-nau, ussú*, etc. A cultivated plant found all over India.

History.

History.—As a spice, the umbelliferous fruits of coriander, commonly though erroneously designated seeds, were well known in Europe in the earliest times of which we have any records. The mention of the resemblance of manna to coriander, combined with the discovery of the latter in early Egyptian tombs, shows it to have been familiar to Egyptians and Israelites before the Exodus. It seems that in ancient times a good deal of the spice came from India to Egypt, and indeed that traffic continued as late as the beginning of the last century. It has now, however, entirely ceased, owing principally to the very extensive cultivation of the plant in Russia, Hungary, Holland, Morocco, and elsewhere. Semler (*Trop. Agrik.*, 1900, ii., 584) points out that all trade in coriander-seed to Continental Europe has now disappeared.

Cultivation.

Cultivation.—Coriander would seem to be sown at various seasons in the different provinces of India, frequently as a mixed crop—the cold season in Bengal and the United Provinces, the rainy season in Bombay and the autumn in Madras. Duthie and Fuller state that it is largely grown in Nepal, whence the fruits are exported to the Basti country. In the Panjáb it is said to be raised in every district, being frequently seen in the fields in a semi-wild state. Owing perhaps to the irregularity of its culture, statistics of the area under the crop or of the annual outturn are not available, and no sufficient data can be obtained on which to base calculations.

Food. Medicine. Oil.

The leaves are eaten by the Natives as a vegetable, also in curries. The fruits (seeds) are universally employed as a condiment; they are one of the ingredients in curry, in confectionery, and in the flavouring of spirits. Many medicinal virtues are also attributed to the plant. From a European point of view by far its most important use is the extraction of a volatile oil. According to Gildemeister and Hoffmann (*Volatile Oils*, 1900, 541-4) this distillation is said to have been first mentioned by Porta in the 16th century; the oil was included in the price ordinances of Berlin (1574) and of Frankfurt-à-Main (1587). It is referred to as an ingredient in sweetmeats in Camerarius' edition of Matthiolus' *Kreütterbuch* (1611, 265 c.). Gildemeister and Hoffmann, moreover, state that a true insight into the composition of the oil was brought about by Semler (1891) and by Barbier (1893). Its sp. gr. is 0·870 to 0·885, and it is soluble in three parts of 70 per cent. alcohol at 20° C. (68° F.). But apparently the constituent to which the specific odour should be attributed has remained undetermined. [*Cf.* Schimmel & Co., *Semi-Ann. Rept.*, 1895, 20-2.] The Indian fruits have the lowest yield of oil, 0·15 to 0·2 per cent., and are accordingly never used for distillation on a large scale. The best fruits for that purpose are those from Moravia, Thuringia and Russia, which manifest a yield of 0·8 to 1·0 per cent. It seems unfortunate that the high prices which have lately been paid for coriander fruits should not have benefited India (Schimmel & Co., *l.c.*, April-May, 1904, 36).

Indian Coriander.

Trade.

TRADE.—The total exports of coriander from India stood in 1903-4 at 62,566 cwt., Rs. 3,87,796—an increase on the 52,827 cwt., Rs. 3,47,318, of 1899-1900—and have since risen to 72,670 cwt., Rs. 7,18,340, in 1906-7. Most of the traffic is from Bengal and Madras to Ceylon and the Straits Settlements. It is not possible to obtain any details of the coastwise or inland traffic, but the plant is largely grown in Nepal and exported thence in considerable quantities to the United Provinces. The price in India is about Rs. 3 per 35 lb.

[*Cf.* Birdwood and Foster, *E.I.C. First Letter Book*, 199, 480, *Paulus Ægineta* (Adams, transl.), iii., 189; *Taleef Shereef* (Playfair, transl.), 82; Hamilton, *Stat. Acc. Dinaj.*, 188; *Rept. Ind. Hemp Drugs Comm.*, iv., 57, 215, 255, etc.; Blochmann, *Beit. zur Entwick. Offic. Samen und Fruchte. Diss. Bern.*, 1901.]

D.E.P., ii., 572-3. Emery.

CORUNDUM, Ball, *Man. Econ. Geol. Ind.* (ed. Holland), 1898, pt. i.; Middlemiss in *Rec. Geol. Surv. Ind.*, 1896, xxix., pt. ii., 39–51; Holland, *Rev. Min. Prod.* in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 105. Emery-stone, *kurund*, *samada*, etc.

It is perhaps unnecessary to do more than refer the reader to the accounts of Indian corundum contained in the publications cited above. The corundum gems, viz. rubies, sapphires, garnets, spinels, etc., will be found under the heading of Gems (pp. 558–60).

Artificial Production.
Substitutes.
Indian Sources.
Assam. Panjáb. Burma.

Holland (*l.c.* 105) observes that the use of abrasives in manufacturing communities seems to be on the increase, and that whereas emery formerly served most requirements, purer forms of corundum have now been discovered in quantity and natural corundum has to meet many artificial competitors. In the United States carborundum is manufactured by electric power to the amount of about 1,700 tons a year; bauxite is used to make artificial corundum at Niagara, and crushed steel is being employed to an increasing extent as a substitute. In India natural corundum is scattered as isolated crystals through the rock, and although for many generations Indian armourers and lapidaries have been supplied from a few comparatively rich deposits, it is doubtful whether these workings will even hold their own against the importation of cheap abrasives, much less prove a paying source for an export traffic. The chief supplies of Indian corundum would appear to be in Mysore and Madras, the total production from the former State having varied from 2,937 cwt., valued at £698, in 1898, to 574 cwt., valued at £108, in 1902. Corundum occurs in Assam, Hyderabad, Panjáb, etc. The deposits of Burma are of course famous for rubies, and since 1882 large sapphires have been obtained in Kashmir. The total production and trade for all India is quite indefinite, since much of the corundum sold in Delhi, Agra, and Jaipur, etc., is casually collected and sold by villagers. Since 1898 considerable interest has been roused by the Canadian separation of corundum from *nepheline-syenite*, such as occurs in the Coimbatore district. The product thus obtained has apparently been found profitable for export.

D.E.P., ii., 575. Hazel.

CORYLUS COLURNA, *Linn.*: *Fl. Br. Ind.*, v., 625; Lawrence, *Valley of Kashmir*, 74, 79, 81; Gamble, *Man. Ind. Timbs.*, 684; *Rec. Bot. Surv. Ind.*, i., 39, 187, 210; Collett, *Fl. Sim.*, 476. The Indian and Constantinople Hazel, *urni*, *winri*, *thankoli*, *jangi*, *shurli*, *ban pálu*, *geh*; CUPULIFERÆ.

Food.
Timber.

This, the Indian representative of the European hazel (*C. Avellana*), is a moderate-sized tree of the North-West Himalaya between 5,500 and 10,000 feet. It flowers in March–April and ripens its fruits in the rains. The nuts are smaller than the European hazel but are very largely eaten and traded in all over India, chiefly by the Kabulis. The Afghanistan and Kashmir nuts are superior to those of the British Himalaya. The wood is used for making spinning-wheels, and invariably for the big spoons with which tea is ladled out; it is moderately hard, does not warp, and shows a grain resembling Bird's-eye Maple.

D.E.P., ii., 575-7. Talipot.

CORYPHA UMBRACULIFERA, *Linn.*: *Fl. Br. Ind.*, vi., 428; Forster, *Pl. Esc.*, 1786, 49; Dodge, *Useful Fibre Plants of the World*, 135, pl. ix.; Semler, *Trop. Agrik.*, 1897, i., 724; Talbot, *List Trees, etc.*, 1902, 313; Gamble, *Man. Ind. Timbs.*, 732-3; Prain, *Beng. Plants*, ii., 1090-1; *Rec. Bot. Surv. Ind.*, iii., 293; PALMEÆ. The true Talipot Palm or *tala*, *tali*, *bajar-battuler* (or *battú*), *tara*, *codda-pani*, *talip-panai*, *shritalam*, *biné*, *pebin*, *pélin*, etc. A tall fan-leaved palm of Ceylon and the Malabar coast, cultivated in Bengal and Burma.

Flowering.

Common in the moist regions of the Madras Presidency and not uncommon in Bengal, where Roxburgh regarded it as "native." It is often planted in gardens near the sea-coast and flowers once, usually when about forty years old, after which it ripens its seed and dies. Many of its uses and vernacular names are identical with those of ***Borassus flabellifer***, the Palmyra or Talipot of Bengal (see p. 170), a circumstance which has given rise to much confusion.

Fans.
Baskets.

The leaves are very large, often ten feet in diameter; are made into fans, mats, umbrellas, etc., very largely worked up as baskets, and strips are utilised as writing materials (*ola*). [*Cf.* Wiesner, *Die Rohst. des Pflanzenr.*, ii., 452–6; Hoernle, Epigraphical Note on Palm-leaf, Paper and Birch-bark, in *Journ. As. Soc. Beng.*, lxix., pt. i., no. 2.] The whole subject of the polished strips of palm-leaves is worthy of careful investigation, since (like those of **Borassus**) they are coming into use in Europe in the construction of ornamental braids. Turning now to the stem fibre, it seems probable that after removal of the pith (to be used as a kind of sago), the long fibro-vascular cords might be employed in the same manner as *kittul* fibre (see Caryota urens, p. 286). The fruits (seeds) are nearly as hard as ivory and are extensively employed in the manufacture of beads, or are coloured and sold as coral, or even made into small bowls, etc. In Europe they are employed in the manufacture of buttons. They are known in the trade as *bazarbatu*, *bajurbet* or *bayurbatum* nuts, and a fairly considerable export in these goes from Bombay. The trade is chiefly carried on by Arabs.

Writing Materials.

Sago.

Fibre.

Ivory Substitute.

Trade.

CRATÆVA RELIGIOSA, *Forst.*; *Fl. Br. Ind.*, i., 172; Gamble, *Man. Ind. Timbs.*, 32; Duthie, *Fl. Upper Gang. Plain*, i., 52; Cooke *Fl. Pres. Bomb.*, i., 42; Brandis, *Ind. Trees*, 32; CAPPARIDEÆ. The *brarúa, barúa, barún, barmál, barana, waruna, bilási, bila, tikto-shak, kúmla, maralingam, bitusi, nirvála, uskia, nirujani, kadet*, etc. A moderate-sized deciduous tree occasionally becoming common throughout India, Burma and Ceylon. In some localities undoubtedly wild (Malabar, Kanara, etc.), in others introduced and cultivated by roadsides.

D.E.P., ii., 583–7

By the earliest writers on Materia Medica (both Native and European) this tree was confused with **Ægle Marmelos**, the *bel* fruit (see p. 26), and both trees are often given the same vernacular names. There would seem to be two varieties, **C. Nurvala**, *Ham.*, and **C. Roxburghii**, *Br.*, of which the former yields a leaf and the latter a bark employed in MEDICINE. It would seem probable that the rubefacient leaves attributed to this plant may in reality be those of **Ægle**—the true *bel*. Like that of the *bel* the fruit is mixed with mortar to form a strong CEMENT, whilst the rind is used as a MORDANT in dyeing. The fruit is also sometimes eaten. The WOOD is employed in the construction of drums, models, writing-boards, combs, etc., but it is not durable and is very liable to the attacks of boring-beetles.

Medicine.

Cement.

Wood.

CROCUS SATIVUS, *Linn.*; *Fl. Br. Ind.*, vi., 276; Maw, *Genus Crocus*, 1886, 56–72, 167–73; also Lacaita, app. i.–xx.; IRIDEÆ. Saffron, *safran, jáfran, zafran, kesar, kecara, kurkum, kunkuma, kásmírajanmá, saurab, kungumanu, kong*, etc. The Crocus would appear to be a native of South Europe, but has long been cultivated at Pampur in Kashmir, and, according to Honigberger, was formerly a State monopoly.

D.E.P., ii., 592–3. Saffron.

The antiquity and value of the Kashmir trade may be inferred from the circumstance that *kunkuma* is mentioned in the Sanskrit Medical Glossary—*Bhávaprakása*—and is referred to by the Emperor Baber (*Memoirs*, 1519, 313), by Abul Fazl (*Ain-i-Akbari*, 1590 (many passages)), and by Jahangir (*Memoirs* (Price, transl.), 125). An interesting account of the modern Kashmir trade is given by Lawrence (*Valley of Kashmir*, 1895, 342–4), who relates a curious legend with regard to its introduction which would seem to involve a great antiquity. The following passages from his account may be here given: "For seed purposes a particular aspect and sloping ground are required, and it takes three years before the bulbs can be planted out in the small square plots where the saffron is to be grown. These plots must remain fallow for eight years, and no manure can be given to them and no assistance given in the way of water. When once the bulb has been placed in the square it will live on for fourteen years without any help from the cultivator, new bulbs being produced and the old bulb rotting away. The time for planting out the bulbs is in July and August, and all the cultivator has to do is to break up the surface gently a few times and to ensure the proper drainage of the plot by digging a neat trench on all four sides. The flowers appear about the middle of October, and the purple blooms and the delicious, though somewhat overpowering, scent of the saffron turn the dry, uninviting plateau above Pámpur into a rare

Kashmir.

Seasons.

Collection.

Grades.

and wonderful garden." "When the flowers are collected the real work of extracting saffron commences. The flowers are dried in the sun, and the three long stigmata are picked out by the hand. The stigma has a red orange tip, and this tip forms the *shahi záfran*, the first-quality saffron. The long white base of the stigma also makes saffron, but it is of inferior quality to the tips. The saffron thus collected in a dry condition is known to the trade as *mongla*, and fetches one rupee per tola. When the *mongla* saffron has been extracted the sun-dried flowers are beaten lightly with sticks and winnowed. Then the whole mass is thrown into water, when the petals swim and the essential parts of the flower sink. The parts which have sunk (*niwal*) are collected, and the parts which have risen to the top are dried and again beaten with sticks and then plunged into water. The process is repeated three times, and each time the *niwal* becomes poorer. One form of adulteration is to mix *niwal* of the third stage with *niwal* of the first process. The saffron obtained in this way is lighter in colour and of fainter scent than the *mongla*, and is known to the trade as *lacha* and sells at twelve annas per tola. The saffron when made is sent to Amritsar and other trade centres by registered post." It has often been suggested that the cultivation might be extended to other parts of India. [*Cf. Journ. Agri-Hort. Soc. Ind.*, 1899, 1054–60; *Planter*, April 21, 1900; etc.]

Uses.

Dye.

Food.

The principal use of saffron is as a DYE and as a colouring material for cheese, puddings, etc. It is too expensive to be extensively employed in India, but is in request at princely marriages, and for the caste markings of the wealthy. Its *supposed medicinal properties are discredited, its position being an element in* "*black magic.*" [*Cf.* Hertodt, *Crocologia*, 1670, 274–8.] As an auspicious colour its use survives in the "Saffron Cakes" of many parts of Europe. For full particulars of the economic and domestic uses consult the *Pharmacographia* of Fluckiger and Hanbury and the *Pharmacographia Indica* (iii., 453–61). Indian cheap substitutes are **Carthamus** and **Nyctanthes.**

Trade.

Trade.—The foreign imports of saffron into India amounted in 1899–1900 to 29,974 lb., valued at Rs. 5,43,038; in 1903–4 to 38,141 lb. at Rs. 6,05,208; and in 1906–7 to 43,727 lb. at Rs. 6,27,333. Almost the whole traffic is from France to Bombay. A small quantity is re-exported to Hongkong and Arabian ports. The total amount in 1906–7 was 6,234 lb., valued at Rs. 61,702. No particulars of the Trans-frontier supply are given in the official publication of the trade of British India by land routes.

D.E.P., ii., 595-613. San-hemp.

CROTALARIA JUNCEA, *Linn.*: Rheede, *Hort. Mal.*, 1689, ix., 47, t. 26; Burmann, *Thes. Zeyl.*, 1737, 82; Rumphius, *Herb. Amb*, 1750, v., 279, t. 96, f. 1; *C. bengalensis and juncea, Lamk. Encycl.*, 1786, ii., 196; *C. juncea, Linn.*, in Roxb., *Corom. Pl.*, 1798, ii., t. 193; *Bot. Mag.*, 1799, t. 490; Roxb., *Trans. Soc. Arts*, 1804, xxii., 369 *et seq.*; 1806, xxiv., 149 *et seq.*; Carey, *As. Res.*, 1808, x., 11–4; *Fl. Br. Ind.*, ii., 79; LEGUMINOSÆ.

History.

Names.

History.—The later Sanskrit authors allude to the *sana* fibre in such terms as to leave no doubt that a fibre of that name has very possibly been known in India from the most ancient times. Jones (*Select. Ind. Pl.* in *As. Res.*, 1795, iv., 296–7) says that the "threads, called *pavitraca*, from their supposed *purity*, have been made of *sana* from time immemorial; they are mentioned in the laws of Manu." But the confusion that to-day is associated with the English word "hemp," it is feared similarly prevailed for many ages with the name *sana*. The account already given of the true hemp (**Cannabis sativa**, pp. 249–56) should, therefore, be consulted, as also that on jute (**Corchorus capsularis**, pp. 409–11), and the observations recorded contrasted with the present description of the *san* or *sunn* fibre. A very extensive series of vernacular names might be given as denoting this plant, such as *san*, *sanai*, *sani*, *sanbu*, *shanal*, *shanambo*, *sanvu*, *sonalla*, *tag*, *ausa*, *suilá*, *junab*, *jenappa* or *janapa* (*shanapam*), *chanam*, *wucku* and *hana* or *sana*. It was customary in India, in ancient times, and in fact is so to-day, to distinguish the various forms of *san* or *pat* by qualifying appellations. Thus, for example, the present plant (to distinguish it from the true hemp) is called *phul-sunn*, *bhágá-sunn*, *bádál-sunn*, *arjha-san*, *san-tág*, or *chunpát*, the last name separating it from jute. The names *ambádi* or *ambári* usually denote **Hibiscus cannabinus**, but *pátsan*, *mestapát* are intended to separate that fibrous plant and its fibre from **Crotalaria** and **Corchorus.** *Sunn*- or *san*-hemp is the commercial name of the present fibre, but it is also known as

Indian Hemp, False Hemp, Brown Hemp, Bombay or Salsette Hemp, Travancore Flax, Jabbalpur Hemp, etc. The names Deccan Hemp or *Ambari* Hemp are sometimes, though incorrectly, given to this fibre ; they usually denote ***Hibiscus cannabinus.***

Distribution.
Jabbalpur Hemp.
Wild Forms.

Though found throughout the plains of India and Ceylon under cultivation (either as a source of fibre or as a special crop to renovate the soil or to be used as a food for milch-cows), it has not very authoritatively been recorded as met with in a wild condition. ***C. tenuifolia***, *Roxb.*, however, by modern botanists, has been reduced to ***C. juncea***, *Linn.* His plant, Roxburgh says, was indigenous to Coromandel. It has since been identified as the special form of ***C. juncea*** grown in Jabbalpur (and thus apparently affords a recognisable trade quality of fibre), but it nowhere has, as yet, been recorded as wild or even as cultivated anywhere between these widely remote localities. It is thus more than probable that either the determination of ***C. tenuifolia*** as the special Jabbalpur hemp is incorrect, or that Roxburgh was in error in regarding it as wild in Coromandel. If it be the Jabbalpur hemp plant, it would seem, from the economic standpoint, desirable that it should be kept distinct from ordinary ***C. juncea.*** Kurz says of ***C. juncea*** that in Burma it grows " like wild, along the banks of the larger rivers."

Recent Experiments.
Indigenous to India.

There are numerous purely indigenous species of ***Crotalaria*** met with all over India and Burma, many of which are weeds of cultivation, tolerated because of their value as green manure. In this connection it may, however, be added that recent experiments conducted at the Royal Botanic Gardens, Calcutta, support belief that all the trade qualities represent seasons of growth or methods of separation of fibre, and not botanical forms. Thus botanical and historic evidence concur in the acceptance of this plant as indigenous to India, even although it has not strictly speaking been found truly wild.

Silence of European Writers.
First Detailed Description.
Roxburgh's Experiments.
Wild in Burma.
Salsette Hemp.
East India Company's Efforts.
Spartum.

But it is very remarkable that hardly any of the early European travellers and botanists in India describe this fibre. Rheede gives an admirable picture of the plant but says nothing of its fibre. Rumphius challenges the accuracy of the statement that a fibre is prepared from the bark, and supposes that the persons who say so had confused this with his *Ganja Sativa*—the " Capsular Corchorus," as Sir William Jones calls that plant. On the other hand, the *Ain-i-Akbari* (1590, Gladwin, transl.) distinguishes two fibre plants—one with flowers like the cotton and the other with yellow flowers. The former was doubtless ***Hibiscus***, and the latter can hardly have been anything else but ***Crotalaria.*** In the *Taleef Shereef* (Playfair, transl., 1833, 98) we learn that the bark of *sana* is used as hemp. Ironside (*Phil. Trans.*, 1774 (ed. 1809), xiii., 506) gives a full description of the cultivation and then adds, " From the bark are made all kinds of rope, packing cloths, nets, etc., and from those when old most of the paper in this country is prepared." Trew mentions that it was introduced into the Physic Gardens of Chelsea in 1744. Hove (*Tours in Gujarat, etc.*, 1787, 93) says that he saw, near Surat, ***Crotalaria*** growing to a height of ten feet. Roxburgh (*Trans. Soc. Arts, l.c.*) gives full particulars of his experiments with both Coromandel and Bengal *san*-hemp. Wissett (*Treatise on Hemp*, 1808) collected together the available information from all parts of the world regarding the better-known forms of hemp. Naturally *san* takes a prominent position in his work. In fact nothing new of importance has been discovered and next to no progress made in the utilisation of this fibre, during the century that has come and gone since Wissett extolled its merits. But it is significant that in his great work only an incidental allusion is made to the jute plant. Jute was at that time viewed as a fibre of little or no importance. Buchanan-Hamilton gives interesting particulars of *san*-hemp cultivation in Dinajpur (*Stat. Acc. Dinaj.*, 200–1), and by Symes (*Acc. Emb. to Ava*, ii., 233) mention is made of Hamilton's having observed it to be " growing spontaneously." Macpherson (*Hist. Europ. Comm.*, 1812, 241, 391) gives the history of the efforts made by the East India Company to have *san*-hemp introduced into England as a substitute for Russian hemp. The Company procured their supplies from Salsette, near Bombay, and sold these for less than they cost and even gave consignments away for nothing, until they had expended £45,000 in the effort to introduce the fibre into European commerce. Yates (*Text. Antiq.*, 1843, 318 *et seq.*), while discussing the Spanish broom or Spartum (***Spartium junceum***) of the ancients, contrasts it with the *san*-hemp of India. Linnæus explains (*Mant. Pl.*, 1771, 439) that he gave the name ***juncea*** (or rushy ***Crotalaria***) to this plant because of its resemblance to the ***Spartium junceum.*** Clusius was of opinion that there were two *spartons* known to the ancients—the one the modern Spanish broom, and the other the modern esparto grass (*Stipa tenacissima*), the *juncus* of dry soils alluded to by Pliny. Etymologically the word *sparton* denotes something twisted, and since both the Spanish broom and the esparto have from very ancient times been twisted into string and rope, both might easily enough have been called *sparton*. It is curious that the *sparton* of the Greeks should have denoted (in one of its meanings) a plant so closely akin to the *sana* of classic India. [*Cf.* Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 84–5.]

Area.

Pure Cultivation.

Seasons.
Kharif Crop.

Bombay.
Rabi Crop.

CULTIVATION.—*Seasons.*—It is not possible to obtain returns of the area under this crop, nor of the extent of the traffic in the fibre, since it is placed under the heading "other fibres" or under "hemp." It is usually grown by itself in small plots or in long strips through fields, but is never apparently produced as a mixed crop proper. Throughout India as a whole it is a *kharif* crop—that is to say, it is sown about the commencement of the rains and cut at the end of September or beginning of October. It is thus off the ground in time to allow of its being followed by a *rabi* crop in the same year. But in some parts of India it would seem there is another crop of *san*. Thus in the Thána and Kolaba districts of Bombay it is sown in November on moist fields near the sea-coast, following early rice. The stalks are pulled up by the roots in March. Hove speaks of the crotalaria of Surat as sown in November. In Khandesh it is sown in June and reaped in October; in Kolhapur the seasons are August and December; in Poona, July and October.

Upper India and Bengal.

Two Kinds.

In the Central Provinces and the United Provinces it is a *kharif* crop, being sown with the advent of the rains, and in Bengal a little earlier, namely from April 15. Roxburgh speaks of it as sown in May and June and as flowering in August. He tells us that Coromandel and Bengal seed were sown in the Botanic Gardens, Calcutta, at the same time in June, but that the former did not commence to flower till October, the latter having been in ripe fruit in September. He accordingly called the Coromandel "Winter Sunn." In the *Ain-i-Akbari*, *sanna* is mentioned as bearing its yellow flowers in spring. Royle (*Fibrous Pl.*, 274), speaking of Commercolly, says there are two kinds—one sown in June and cut in August, the other sown in April; but this latter kind, he adds, is in Dacca sown in October. In Madras the sowings would appear to be even still earlier, namely February 15.

Sowings.

Special Qualities.

Experimental Cultivation.

Thus while the mean period of sowing is about the beginning of the rains (or in June), *san*-hemp may be sown in almost *any month*, and occupies the ground from four to five months. This is an important feature, and doubtless accounts for the varying colour and quality of the fibre in market. It seems, in fact, of vital importance to bear this in mind, in view of future efforts at extended production. It is difficult to believe that, as with rice, so with *san*, a wide range of sowings could be possible unless the plants are accepted as representing different races and hence very possibly different qualities of fibre produced after centuries of adaptation to various environments. In fact it would seem fairly certain that these climatic conditions, though they cannot be identified by the botanist as separable varieties or even races, are nevertheless industrially quite distinct. To grow a *rabi* crop during the *kharif* season or *vice versâ* may be to destroy entirely its distinctive merit. This subject has not as yet received the degree of attention that it deserves. We have been content to read of special qualities of fibre without any attempt having been made to ascertain whether these are due to superiority in stock, to climate, to seasons of cultivation or to method of preparing the fibre. It would seem from the Calcutta experiments that all the forms hitherto grown from seed procured from such remote localities as Vizagapatam, Jabbalpur, Phillibit, etc., have resulted in plants of varying stature, size of flower, etc., but in no structural departures that could justify even varietal positions being assigned to them.

Soil.

Soil.—When grown as a fibre crop it requires a light and not necessarily a very rich soil. It cannot be grown on clay nor on inundated lands. It flourishes on moderately deep and fairly retentive soils, such as those used for irrigated crops. But when raised with a view to soil-improvement it might be grown on almost any soil. The practical experiments that have been performed would seem to show that when cultivated on too rich soils the merit of the fibre deteriorates. Wissett, for example, remarks that it will not grow at all on clay soils, that on rich soils the fibre becomes coarse and on high and dry soils it is best of all. On the other hand Roxburgh, speaking of *C. tenuifolia* and of the North Circars, affirms that strong clay soils suit it best.

Green Manure.

Green-manuring.—The cultivators of India have all along recognised this plant as a useful aid in soil-improvement. It may for that purpose (more especially when employed exclusively as a green manure) be grown on all sorts of garden soils and rice-fields, especially if infested with weeds (see **Vitis**, p. 1116). For this purpose it is usually uprooted when two to two and a half months old and then ploughed in, especially when followed by potatoes. The cultivators regard renovation in this manner as preferable to a manure of one to two maunds of oilcake per acre. It is therefore surprising that the practice is not more general. Early ploughing is of course involved and more labour than is customary has to be given. Mukerji (*Notes on a Tour in the Jute Districts*) says :—

Preferable to Oilcake.

Objections to its Cultivation.

Retting offensive.

> "The cultivators were asked why they did not grow *san*-hemp more largely as a *rabi* crop and a preparatory crop for the jute when they themselves asserted that by doing so they got two maunds of jute more per *bigha*. They replied that they must grow *kalai* and other food-crops, and that one special objection to the *san*-hemp was the retting of it produced a most filthy stink which was unbearable to them, and as there is water only in tanks and *khals* at the dry season when *san* is retted in this district, fish die off if retting of *san* is done in the tanks and other places where there is fish. Owing to these objections, they cannot grow *san*-hemp extensively, but the cultivation of this useful crop is evidently extending. *Kalai* and mustard are the standard *rabi* crops here, but a good deal of *san* is grown chiefly with the object of benefiting the succeeding jute crop.

Ghati Variety.

> "Why a short variety of *san* (called *ghati*) should be chosen for feeding cattle and afterwards ploughing in as green manure does not appear clear. The taller variety, though better suited for extraction of fibre, also seems to be more valuable for manurial purposes, as it has far more organic matter in it and the root residue must be also larger. The *raiyats* recognise that the growing of the larger variety for fibre also has a beneficial effect on the soil."

Tillage.

Weed-killer.

Tillage.—*San*-hemp is most in favour as a catch crop. The seed is sown thickly, hence the value of the crop as a weed-exterminator. In some reports as much as 80 to 120 lb. of seed to the acre are spoken of, in others 40 lb., and in still others half that amount. The plants should be from 3 to 4 inches apart each way. Mollison (*Textbook Ind. Agri.*, iii., 226) observes that a luxuriant crop cannot be grown without careful tillage. Quick growth is necessary whether raised for fibre or as a green manure. "A smooth friable bed is, therefore, required, and this can only be obtained by ploughing and repeated harrowings. The seed is generally drilled in July; in the Deccan with a four-coultered drill, first lengthwise then

Quick Growth.

Drill-sown.

across the field. The drill coulters are 12 to 14 inches apart, and the double drilling secures even distribution of the necessary heavy seed rate (about 70 lb. per acre). If the seed germinates properly, no further culture is required until the crop is ploughed in as green manure or reaped for fibre."

Harvest.

Diseases and Pests.—Very little is known regarding the enemies of this plant. Maxwell-Lefroy (*Agri. Journ. Ind.*, i., pt. iii., 187–91; also *Membirs, Dept. Agri. Ind.*, 1907, i., 158, etc.) gives particulars of three moths, the caterpillars of which often do much harm to the crop.

Pulled up by the Roots.
Left to Dry.
Withering.
Not practised in Bengal.

Harvest.—It is customary to read that the crop is harvested after the flowers have appeared, but in certain localities the plants are left on the field until the fruits have begun to form, and in some instances even until they are ripe. "The finest, strongest and best fibre may possibly be got from plants which are not dead ripe, but very good fibre as well as seed are got from a ripe crop" (Mollison). In most cases the plants are pulled up by the roots, in others the stems are cut with a sickle close to the ground. They are left on the field for a few days to allow of withering, and are then stripped of their leaves; these are regarded as a necessary return to the soil. The stems are tied into neat bundles that may be easily handled, each containing not more than 100 stalks. The bundles are then preserved for two or three weeks until they are thoroughly dried, and the remaining leaves and seeds are thereafter thrashed out. But as with jute so with *san* fibre, much difference of opinion prevails regarding the nature and extent of withering necessary before subjection to retting. Mukerji (*Handbook Ind. Agri.*, 307) says that in the damp climate of Bengal stacking before retting injures the fibre. Stacking is therefore very little practised in that province.

Separation of Fibre.

Five Days' Retting.
Stagnant Water.
Salsette Method.
Stacking till Convenient Season.

Separation of Fibre.—The dried bundles are tied into larger bundles, then placed in pools of water and weighted with stones or logs of wood, until they are completely submerged, much after the fashion detailed regarding jute, only that since the steeping takes place usually in the hot months, a period of five days is ordinarily sufficient, but in cold weather eight or nine days may be required. In some instances retting in damp mud on the margins of tanks or lakes seems to be the system followed; in others complete submergence in water is deemed essential. By some writers stagnant water is condemned as destroying the colour and lustre of the fibre, running water being advocated as preferable. But this seems a mistake, as longer retting would certainly be required in running water. It is also sometimes customary to set the lower and thicker ends of the stems into water for twenty-four hours, so as to secure for these a longer retting than is necessary for the upper portions. In deep water longer retting is required than in shallow. In Salsette there is said to be very little retting, and this circumstance is claimed as the reason of the superiority of the fibre there produced. In many localities the complaint is made that sufficient water does not exist at the harvest season to allow of an extended production. This difficulty, it would seem, might be easily and conveniently disposed of by drying the stems and stacking them till a more convenient season. Districts with a limited supply of water are those where stacking would be easy. The stacking of hemp is moreover believed, if anything, to improve the fibre, and should be tested with *san*-hemp.

Stripping and Washing.

The process of stripping and washing the fibre is very similar to that pursued with jute, but more difficult and laborious. The strips of fibre are repeatedly beaten on a stone with a stick, then lashed on the surface of the water. This beating and lashing may have to be repeated two or three times before a thoroughly clean fibre is produced. The hank of fibre is now wrung out, to remove the water, twisted and folded into a particular fashion, and hung out to dry and bleach. It is then plaited threefold into a tail, and in that form is usually seen in the market, but it has often been urged that it would be advantageous to discontinue the habit of plaiting the fibre. It will thus be noted that regarding each and every stage in the separation and cleaning there is as great a divergence of opinion as with most other aspects of the industry.

Plaited Tails.

Divergence of Opinion.

If required for textile purposes, however, or even for the string employed in the construction of fishing-nets, it is opened out and combed or crudely scutched. In most of the reports furnished in Europe regarding this fibre its shortcomings are attributed to incomplete or excessive retting or to imperfect cleaning, breaking and scutching, never to inherent defects in the fibre itself. The loss between washed and scutched fibre is about one-third the weight. Hence the difference in price offered does not, as a rule, tempt the growers to go in for much cleaning.

Imperfections.

Scutched Fibre.

Yield and Price.—It is generally said that the finest qualities fetch in India about one rupee for five pounds. As met with in the bazárs *san* fibre occurs in tangled masses of a dull greyish or greenish-white colour. An official of the Calcutta Custom House, to whom an application was made for information regarding the trade in Indian hemp, furnished in 1901 many useful particulars. The best country hemp comes from Bombay and is called Rajpore or Dugaguddi; it is about four feet long and fetches Rs. 16 to 18 per cwt. The next best is the Jabbalpur, the value of which is Rs. 11 to 13 per cwt. The third grade is Phillibit and the last the Bengal. The exports are chiefly in the most inferior stuff. In Messrs. Ide & Christie's *Monthly Circular* quotations are made of Allahabad, Jabbalpur and Bengal hemps, and these would seem to average from 14 to 18 shillings. But a particular shade of colour is desired, and parcels with that colour fetch higher prices, irrespective of strength, the object being to allow of admixture with Russian hemp. Mollison records the yield of an experimental cultivation in Poona. The dried stalks scaled 6,280 lb. and the cleaned fibre 520 lb. per acre. Mukerji gives the yield as 200 to 1,200 lb., or an average of 640 lb. (8 maunds) per acre, worth Rs. 50. A sample examined at the Imperial Institute in 1896 was valued at £15 to £16 a ton in London.

Price.

Grades.

Rajpore.
Jabbalpur.
Phillibit.
Bengal.

Price.

Colour.

Yield.

Properties and Uses of San Fibre.—For results obtained by the early experimenters consult the *Dictionary*. Although the Indian factories use a fair amount of *san* in the production of the rope and string generally spoken of as country-hemp, little or no progress has been made to place the production on a sound basis. Madras and Bombay might each have an industry, which if it did not rival the Bengal jute trade might meet some of the markets for that fibre and supply a want for an article of a slightly higher quality. It is indeed surprising that this fibre has not by now become an established and valued feature of the commerce and industry of India. Some few years ago, as co-author of a small book on the *Indian Fibres and Fibrous Substances* (Cross, Bevan, King and Watt, 1887, 28–30), I wrote, "It is impossible to urge too strongly the claims of this much-neglected fibre—a fibre which seems to have suffered severely through the immense success of jute obscuring for a time the properties of all other

Uses.

Rope and String.

Much-neglected Fibre.

Better Qualities not Procurable.

Chemical Examination.

Ultimate Cell.

bast fibres." "During the Colonial and Indian Exhibition numerous inquiries were made as to why it was that so little of the better qualities of *san*-hemp were procurable. Mr. Collyer and several other brokers and merchants stated that their only difficulty in pushing the trade in *san*-hemp was their inability to procure a uniform and a large enough supply." Dunstan (*Imp. Inst. Tech. Repts.*, 1903, 70) similarly observes, "The literature on this fibre is extensive, betokening much interest in its qualities, but up to the present the material has been exported only to a small extent." Two sets of samples were sent to him for examination, viz. from Burma and Calcutta. The results of the chemical analyses of these are given, and it may be said that the ash in the Calcutta sample was considerably higher than in that from Burma, but all the features brought out were regarded as indicative of high quality. Microscopically the ultimate fibres were found to be rather long—5 to 8 mm.—and seen to end abruptly instead of tapering, while the walls were rough and irregular in outline.

Utilisations.

Fishing-nets.

Tanned.

As to the utilisations of the fibre, these may be briefly stated as identical with those of true hemp—namely the production of cordage and canvas, the waste or tow going to the paper mills. But in India by far the most important use is the employment of *san*-hemp for the cordage of fishing-nets. In this connection it may be mentioned that Mr. V. P. Ribeiro, Sub-divisional Forest Officer, Bassein, West Thána, contributed to the Reporter on Economic Products a most interesting account of the deep-sea nets used by the Koli fishermen (since published in the *Agri. Ledg.*, 1905, No. 7). These are huge traps 160 feet long and 70 feet in diameter. They are constructed entirely of *san*-hemp, and may cost as much as Rs. 250 each. The mesh decreases from 6½ to ¼ inches progressively, from the mouth to the apex of the net. The fibre is carefully tanned. The repairing and tanning of the net cost about Rs. 8 a month. The inference from this is that the fibre is only durable under sea-water when fully tanned. The woodwork of these deep-sea nets, it may be added, is preferably that of ***Adina cordifolia***. Throughout India fishing-nets are largely made of *san*-hemp, though not exclusively so. Those of Karachi are chiefly *madar* or *akanda* fibre (**Calotropis gigantea**, p. 207) and those of Assam and Eastern Bengal *rhea* fibre (**Bœhmeria nivea**, pp. 146, 157).

Exports.

Imports.

TRADE IN SAN HEMP.—As already observed, nothing of any value can be said authoritatively regarding the extent of production or utilisation of this fibre, since it is not separately recorded in the *Trade and Agricultural Statistics*. It is grown in every province, and nearly universally used by the people of India. It seems probable, however, that of the exports to foreign countries shown as "Raw Hemp" of Indian produce, a large proportion is *san*. The only other fibre of importance (and that one of comparatively recent origin) is indicated by the exports of Indian Agave fibre (Sisal hemp). Of the imports of raw hemp the major portion is doubtless Manila (***Musa textilis***), and lastly of the imports of hemp manufactures the major portion is doubtless canvas and rope of Russian hemp. The traffic under these headings may be here exhibited :—

EXPORTS.	1876-7.	1886-7.	1896-7.	1905-6.	1906-7.
	Rs.	Rs.	Rs.	Rs.	Rs.
Raw	7,58,856	16,41,384	23,11,179	54,19,756	68,73,395
Manufactured	2,035	262	15	*nil.*	240
TOTALS	7,60,891	16,41,646	23,11,194	54,19,756	68,73,635

IMPORTS.	1876-7.	1886-7.	1896-7.	1905-6.	1906-7.
Raw	1,33,990	1,71,795	2,93,157	6,52,777	6,94,623
Manufactured ..	3,108	42,623	69,930	45,066	32,330
TOTALS ..	1,37,098	2,14,418	3,63,087	6,97,843	7,26,953

It will thus be observed that while both the exports and the imports have increased very considerably within the past twenty-seven years, a scrutiny of the details reveals the fact that the most important improvement has taken place within the last six or seven years and is due mainly to the expanding supply of Indian Aloe Fibre (see **Agave**, 44-5).

D.E.P., ii., 617-20. Croton.

CROTON TIGLIUM, *Linn.*; *Fl. Br. Ind.*, v., 393; *Pharmacog. Ind.*, iii., 281-6; Gamble, *Man. Ind. Timbs.*, 1902, 614; EUPHORBIACEÆ. The Purging Croton, *jaya-pála*, *jaypál*, *kanakaphála*, *jamál-gota*, *nepál*, *nerválam*, *kanako*, *bori*, *dand*, etc. A small tree met with under cultivation throughout the greater part of India; said to be naturalised in Eastern Bengal, Assam, and elsewhere.

Gamble states definitely that it is not indigenous. It was apparently first described by Acosta in 1578, and subsequently by Rheede in 1679, then by Rumphius in 1743. The purging croton grows on the poorest soils, such as waste lands, from the sea-level up to about 3,000 feet. Under cultivation no special care is necessary, and it will fruit in the second year. It has been spoken of as a shade-tree for coffee. A little of the powdered oilcake forked into the soil has been recommended as a protection for tea and other plants from grub and white ants. The nuts yield a large amount of medicinal OIL which may be administered as a violent purgative, or applied externally as a powerful vesicant. An inquiry made by Prof. W. R. Dunstan and Miss L. E. Boole into the nature of the vesicating constituent resulted in their obtaining "a small quantity of a yellow oil which, after a time, became a transparent resinous mass, intensely active and burning without ash. It was found that *crotonoleic acid* owed its vesicant properties to a small proportion of this resin, to which the name of 'croton resin' has been provisionally given" (*Imp. Inst. Journ.*, 1896, ii., 264). It is said that croton oil is used by fraudulent manufacturers as an adulterant of tincture of iodine. [*Cf. Brit. and Col. Drugg.*, 1901, xl., 176.] The seeds have similar properties to the oil and are fairly largely used by the Natives of India. Kino-like exudation has been discussed by Hooper (*Rept. Labor. Ind. Mus.*, 1905-6, 34). Messrs. Hearson, Squire & Francis say that if the London price be taken as 25*s.* to 35*s.* per cwt., the freightage, insurance and brokers' commission would have to be borne by the shipper. It is better to express the oil before transit since much is lost on the voyage. For kino see **Pterocarpus Marsupium** (p. 908).

Cultivation. **Medicine.** **Vesicant.** **Trade.**

D.E.P., ii., 626-38.

CUCUMIS, *Linn.*: *Fl. Br. Ind.*, ii., 619-20; DC., *Orig. Cult. Plants*, 258-62; Cogniaux, DC., *Monog. Phaner.*, iii., 479-507; Cooke, *Fl. Pres. Bomb.*, i., 534-6; Duthie, *Fl. Upper. Gang. Plain*, i., 371-4; Prain, *Beng. Plants*, i., 522-3; CUCURBITACEÆ. A genus of climbing herbaceous plants which embraces twenty-eight species, of which more than half are recognised as African and only three or four Indian. It is noteworthy, however, that of the Indian forms, two are the Melon and Cucumber (economically very far the most important of all) and the third is *C. trigonus*, *Roxb.*—a truly wild plant, never cultivated nor its fruits eaten.

Sweet Melon or Karbuz.

C. Melo, *Linn.*; Duthie and Fuller, *Field and Garden Crops*, pt. ii., 51, pl. 1; Sweet Melon, *kharbúja*, *karbuz*, *kharmuj*, *tarbuj*, *dungra*, *chibúda*, *gidhro*, *zaghún*, *sarda*, *vellari-verai*, *mulam-pandu*, *remó*, etc.

History.

Most of the early travellers speak of the best melons of India being grown from imported seed. The Emperor Baber makes, in fact, no mention of Indian melons, but extols those of Samarkand. So also in Akbar's time none of the

The *Sarda* Melon of Kabul.

Safedah Melon of Lucknow.

five sorts spoken of in the *Ain-i-Akbari* (Blochmann, transl., 65) were Indian; all are stated to have come from Badakshan or Kabul. Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), ii., 35) observes that the Indian melons are not so good as those of Spain, and have to be eaten with sugar. Tavernier speaks of the Indian melons as grown from Persian seed. Firminger (*Man. Gard. Ind.* (ed. Cameron), 1904, 225–9) mentions several kinds of melons as specially excellent. The best or first class is the *sarda*, a native of Kabul, which does not succeed in India; the second is also a Kabul melon successfully grown in India. Aitchison (*Prod. W. Afghan. and N.E. Persia*, 48–9; *Kew Bull.*, 1894, 75) is of opinion that the *sarda* failed because it was not understood. The early supply consists of ordinary good melons, but the later, when ripened with frost, is the *sarda* proper. It is covered over and left to mature slowly. Some *sarda* melons sent to Kew in 1894 arrived in excellent condition, and from the seed thus obtained good fruits were grown at the Royal Gardens at Frogmore and elsewhere. It is believed that *sarda* melons might be exported to Europe, where they would fetch good prices as winter fruits. The *third* and perhaps the finest of the Indian melons is the *safedah* or white melon of Lucknow, which is grown in sandy loam along the banks or in the dry beds of the Gumti. It is the size of a very large orange, flattened at both ends and white inside and out. It would appear, however, that so far back as 1866 the Lucknow melon had been allowed seriously to deteriorate, so that perhaps its present condition might be considerably improved. In *The Indian Agriculturist* (June 12, 1866) Dr. E. Bonavia gave an interesting account of this deterioration, and urged that efforts should be made to improve the stock of the "*chitla*" or "speckled" melon of Lucknow.

Cultivation for Food.

Floating Gardens.

The Melon from an agricultural point of view is the most important species of the genus ***Cucumis***, and is extensively cultivated for its fruits on the sandy banks of Indian rivers. So soon as the water has fallen from the white sandy banks of the Ganges and Jumna, for example, pits are dug and filled with manure within which the melon-seed is deposited. These pits act as forcing-beds and are protected against sand drift by grass and thorn hedges constructed around them. Less manure is required when the silt of the river is of fairly rich quality and contains organic matter. Sometimes, as at Ahmedabad, the plants are sown in trenches instead of pits. They continue to fruit as a rule from April until the rising of the water in June overwhelms and destroys them. A popular account of the Indian melons may be found in *Indian Planting and Gardening* (Oct. 3, 1904), and interesting descriptions of the growth of melons on the floating gardens of Kashmir are given by Moorcroft (*Agri.-Hort. Soc. Ind. Trans.*, i., 70), by Rivett (*Assess. Rept. Mir Bahri*, 1898, 16), and by Lawrence (*Valley of Kashmir*, 345–8).

Oil.

Medicine.

The flattened and elliptic seeds yield a sweet edible OIL. Semler says the quantity they contain is about 30 per cent. and that a considerable trade in it exists from the Chinese port of Chefoo. It is a light thin oil, which dries slowly and in addition to being eaten is employed in the soap industry. According to Semler a considerable quantity was formerly exported from Sierra Leone and Lagos, but the low prices offered have killed the trade (*Trop. Agrik.*, 1900, ii., 525). The seeds are also used as a cooling MEDICINE, though it is doubtful if those of the various species are distinguished. In fact the seeds of ***C. Melo*** are commonly sold all over India as a cooling medicine in admixture with those of ***C. Melo, var. utilissima, Benincasa cerifera*** and ***Citrullus vulgaris***. Melon-seeds are also commonly used as a flavouring ingredient—*bhang-massala*. [*Cf.* **Cannabis sativa**, p. 258.]

Pests.

Pests.—Particulars of the cultivation of Afghan and Baluch melons in the Lower Provinces, together with a description of the life history of the troublesome melon-fly, may be found in Jas. Cleghorn's most useful paper (*Journ. Agri.-Hort. Soc. Ind.*, n.s., 1891, ix., 63–82). The melon is also attacked, like other cucurbitaceous fruits, by a small red beetle. [*Cf. Ind. Mus. Notes*, i., pt. ii., 92–3; iii., pt. v., 57–8; iv., pt. i., 32–4, pt. ii., 92–3.] The wood-ash preventative, usually adopted by the Natives, must be detrimental, and probably a muslin frame would be found more effective, since only the young seedlings suffer as a rule.

Phut and Kachra.

(*a*) **var. Momordica,** *Roxb., sp.*; Duthie and Fuller, *l.c.* 50, pl. xlix.; Banerjei, *Agri. Cuttack*, 1893, 116. The *phut* or *phúnt, phúti, kachra* (unripe), *tuti, kakari-kai, pedda-kai, thakhwa hmwey*, etc. Mentioned as *phooth* in the *Taleef Shereef*, and according to Dutt has a Sanskrit name, *ervaru*. Although now reduced by botanists to a variety of **C. Melo** the fruit is cylindrical, smooth (not fluted), mottled yellow and green and more like the cucumber, except that it is less scabrous and larger. There are several distinct forms met with in the hot and rainy seasons. It is cultivated in cotton or maize fields, etc., here and there throughout India, and when the fruit has burst, which it does spontaneously, the flesh is mealy but not sweet, though palatable when eaten with sugar. When young the fruit is a good substitute for the cucumber, and *kachra* is in fact a valuable vegetable.

Kakri.

(β) **var. utilissimus,** *Roxb., sp.*; Duthie and Fuller, *l.c.* ii., 55, tt. liii., liv. The *kákri, kákúr*, or *kánkur, kukri, dosray, velliri, kakkarik, kakadi, kakdi, tarkakdi, takhva, tavashi*, etc. This melon approaches the cucumber. According to Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 196) it is the fifth most important fruit. It varies from short oval to elongate (sometimes three feet in length). When young it is covered with soft down and is pale green in colour, but with age changes to dark green or white and bright orange when fully ripe.

Cultivation.

It is cultivated in Bengal, the United Provinces, the Panjáb and Western India, etc., during the hot weather and the rains. It prefers a dry, loose, open soil. After manuring the ground should be laid out in beds and three or four seeds sown three feet apart. Being in season long before the cucumber, the young fruit is much eaten by Europeans as a substitute for that vegetable, though it is somewhat insipid.

Food.

Kakri is moreover an important article of FOOD with the poorer classes during the hot months. When half-grown it is pickled; when ripe eaten raw or in curries. The seeds are pressed, dried, ground to meal; the oil expressed from them is used with food, in medicine, or in lamps. It seems probable that some at least of the forms spoken of by authors as cucumbers should in reality be placed under the present plant.

Cucumber or Khíra.

C. sativus, *Linn.*; Duthie and Fuller, *l.c.* 53-4, tt. li., lii.; Sen., *Rept. Agri. Stat. Dacca*, 1889, 47; N. N. Banerjei, *Agri. Cuttack*, 1893, 115; Firminger, *l.c.* 169. The Cucumber, *khira, kaknai, kakdi, sasá, muhevehri, dozakaia, sante kayi, trapusha, sukasa, thagwa, lár*, etc.

Habitat.

There seems to be no doubt that one at least of the original homes of the cucumber was in North India, and its cultivation can be traced to the most ancient classic times of Asia. Royle's **C. Hardwickii** (a plant wild from Kumaon to Sikkim) is in no important respect different botanically from **C. sativus**, though it has distinctive vernacular names (*air-álu, páhari-in-drayan*, etc.), and is collected and used as a substitute for **Colocynth** (*Illust. Him. Bot.*, t. 47). The classic and other European names for the cucumber, as stated by De Candolle, would seem to point to a European cultivation quite as ancient as can be shown for Southern Asia. Hehn (*Kulturpfl. und Haust.*, 6th ed., 1894, 308–14) gives a useful account of the historic and etymological considerations. Briefly it may be said that he, and his editors Schrader and Engler, refer most of the early names for the cucumber, the melon and the gourd to the uses of certain forms of these fruits as water and oil bottles. [*Cf.* **Cucurbita**, p. 441, and **Lagenaria**, p. 700.]

Forms.

There are two primary forms of cucumbers:—a creeping field plant of the hot weather, and a garden climber of the rainy season. The former has small egg-shaped fruits (*mandi kakuri* of Orissa) and is sown in drills in February or March, preferably in rich soil. The latter or rainy-season varieties have much larger fruits (*kantali kakuri*), dark-green or creamy-white, changing to rusty-brown when full grown. The rainy-season varieties are the most common, being eaten by both Natives and Europeans. The hot-season forms are also, however, eaten either raw or cooked in curries.

Gherkin.

Gathered in a young state they are generally known under the name *gerkin* or *gherkin*, and constitute a much-prized vegetable; they are also very extensively pickled and eaten in that form. It would thus seem fairly certain that the *gherkin* of India is the hot-season form of **C. sativus** and not the somewhat doubtful **C. Anguria** of the West Indies. Sir J. D. Hooker (*Bot. Mag.*, t. 6206) has described a special form of cucumber that seems peculiar to Sikkim.

Cultivation.

In the hot-weather supply three sowings are usually made, namely at the end of February, in the middle and at the end of March. The seeds are sown along both sides of drills, the drills being one foot apart. In dry soil, water is given immediately after sowing and subsequently every ten days, but not too liberally. The rainy-season forms thrive with little care, and are always sure of yielding a good crop. The creamy-white kind ("White Turkey") is regarded as one of the best forms. European cultivation has recently completely changed the character of the plant met with in Indian towns. [*Cf Ind. Gard.*, Dec. 21, 1899.] Still it is a curious fact that although the cucumber is now fully acknowedged to be a native of India, most of the fine English forms cannot be grown in that country.

Kárit, Katvel.

C. trigonus, *Roxb.*, *Fl. Ind.*, iii., 722; also *C. turbinatus*, *Roxb.*, 723; *Pharmacog. Ind.*, ii., 65–7; Kartiker, *Pois. Pl. Bomb.*, in *Journ. Bomb. Nat. Hist. Soc.*, viii., 99–106, pl. G.: Duthie, *Fl. Upper Gang. Plain*, i., 373; Prain, *Beng. Plants*, i., 522; Cooke, *Fl. Pres. Bomb.*, i., 535; *C. pseudo-colocynthis*, *Royle*, *Ill.*, 220, t. 47, f. 3; *C. pubescens*, *Wall; Royle; Wight*, etc. The *kátvel, kárit, pam-budinga, pulcha, puchcha, bislumba, bislambhi*, etc. An annual or perennial climber not cultivated, met with throughout the greater part of the drier upland tracts of India, Afghanistan and Persia.

The name *Indrayan* sometimes given to it more correctly denotes ***Citrullus Colocynthis***, but I strongly suspect these two plants, and also the so-called wild states of ***C. sativus*** (***C. Hardwickii***, *Royle*) have been much confused by economic and even by some botanic writers. The character of simple bifurcated tendrils would, if rigorously applied, almost of necessity involve the transference of one-half the sheets in most herbaria from ***Citrullus Colocynthis*** to ***Cucumis trigonus***. Indeed, all the examples of ***Citrullus*** with small deeply dissected leaves have simple tendrils, and can with difficulty be separated from ***Cucumis pseudo-colocynthis***, *Royle*. It is necessary to draw attention to this circumstance since the properties of the *kárit* do not differ materially from those of the true ***Colocynth***. But the plant of the sandy deserts is very different from that of the Himalaya, and there may be two or more species; but if so, then they have been very indifferently described and identified. Roxburgh pointed out that his ***C. trigonus*** resembles very much ***C. Melo***, *Linn.*, *var.* ***utilissima***, and Prain says ***C. trigonus*** is sometimes considered the original source of the melon, and may equally be a form of that plant which had become feral.

The seeds yield a fixed OIL by boiling, which is used in lamps by the poorer classes. The pulp of the fruit is bitter and similar in quality to ***Colocynth***. It is not, however, possible to ascertain definitely the exact industrial and medicinal value of this species until the ambiguities above indicated have been removed.

D.E.P., ii., 638–42.

CUCURBITA, *Linn.*; *Fl. Br. Ind.*, ii., 621–2; Cooke, *Fl. Pres. Bomb.*, 1903, i., 547; Duthie, *Fl. Upper Gang. Plain*, i., 377; Prain, *Beng. Plants*, 1903, i., 524; CUCURBITACEÆ.

History.—Considerable confusion appears always to have existed as to the history and nomenclature of most cucurbitaceous plants. It seems probable that European pre-Linnæan names are suggestive of the first uses to which the fruits were put, but can hardly be accepted as separately denoting the modern genera and species. Thus, for example, Pliny (*Hist. Nat.*, bk. xix., ch. 5) observes that cucurbitaceous fruits had long been used as wine-bottles, but in his day were just coming into fashion as water-pitchers at the baths. Hehn (*Kulturpfl. und Haust.*, 6th ed., 304–14) derives conjecturally ***Cucumis*** and ***Cucurbita*** from *cumera* and *corbita*, low Latin words, the one meaning a covered vessel, the other a basket (Germ. *korb*). Hence perhaps the remark by Columella (*De re Rust.* (ed. Gesnero, 1773), xi., 3, 49), these fruits "are well suited for employment as vessels." Incidentally it is worth noting that many of the early glass bottles recovered from the Thames, Tiber and Seine are obviously modelled on the bottle-gourd (***Lagenaria vulgaris***), and some of the bottles used for Italian wines are to-day of that shape. It is thus not surprising that statements sometimes applied to ***Cucurbita*** should have to be transferred to ***Lagenaria*** or ***Benincasa*** or *vice versâ*. Still more frequently are the various species of ***Cucurbita*** confounded one with the other and their vernacular names in all countries interchanged. Brief botanic diagnoses for the purpose of facilitating distinction become accordingly almost imperative.

Water and Oil Bottles.

C. maxima, *Duchesne*; *Fl. Br. Ind.*, ii., 622; Bentham, Rev. on *Cenni storici* of Targioni-Tozzetti, in *Journ. Roy. Hort. Soc.*, 1855, 146; DC., *Orig. Cult. Plants*, 1884, 249–57; Asa Gray, *Scient. Papers*, 1889, i., 332–41; N. N. Banerjei, *Agri. Cuttack*, 1893, 116–7; Cooke, *Fl. Pres. Bomb.*, 1903, i., 547; Duthie, *Fl. Upper Gang. Plain*, i., 377. Squash-gourd, Yellow-gourd, Red-gourd, Spanish-gourd, Turban-gourd, etc.; *lal bhopali, kala-bhopala, baitalu, baitaka-kharu, kadú, tookm kudú, gaduwa, pushini, gummadi, erra-gummadi, mattanga, kumbala, shwé-pay-on*, etc. A plant with five palmate leaves, having the lobes rounded, the sinus narrow, and the petiole nearly as long as the blade, but not prickly; fruiting peduncle round, smooth; corolla lobes curved outwards; calyx segments lanceolate-linear.

D.E.P., ii., 638–40. Squash- or Yellow-gourd.

Habitat

Duthie says that the evidence obtained from historic research favours an Asiatic origin for this plant, C. Sprenger (*Bull. Tosc. Ortic.*, 1893, 333) says a wild form, ***C. maxima*** (***sylvestris***), has been found in the Himalaya which is supposed to be the parent of all the large-fruited gourds in cultivation. [*Cf. Kew Bull.* (add. ser.), 1900, iv., 120.] Asa Gray is disposed to accept it as American, and in support of that opinion mentions that its name "Squash" is American. It produces the largest known cucurbitaceous fruit; examples weighing as much as 240 lb. have been recorded. The principal varieties have already been denoted by the citation above of European names. It is cultivated in most warm and temperate parts of the globe. In Upper India the seed is sown in the rains and the vegetable eaten in the cold season; but in Bengal it is often sown in October, and Banerjei says that in Cuttack it is sown in February–March. Both the seeds and the OIL expressed from them are used in medicine. The fruit when young is used as a VEGETABLE, and when mature will keep for months if hung up in an airy place. It is, like most other forms of ***Cucurbita***, extremely valuable as a vegetable during camping expeditions, since it will keep for months and withstand severe handling. It is largely used by the Natives in curry. In German East Africa the young leaves are eaten like spinach. [*Cf. Berichte über Land-und Forst.*, 1903, i., 419.] In Assam the young leaves of ***C. Pepo*** are similarly eaten as a pot-herb.

Cultivation.

Oil.

Vegetable.

C. moschata, *Duchesne;* Duthie and Fuller, *Field and Garden Crops*, pt. ii., 58–9, pl. lviii–lxi. The Musk-melon, Melon Pumpkin, *sitaphal, saphari khumra, míthá-kaddú, kali-dudhi*, etc.

D.E.P., ii., 640–1. Musk-melon.

Leaves as in the preceding, but very often marbled with whitish blotches; petiole hairy but not prickly; fruiting peduncles angular and furrowed; calyx segments of the female flower large foliaceous. The Musk-melon is described in the *Ain-i-Akbari* (Blochmann, transl., 64–5) as distinct from the melon, so that it appears to have been known in India from fairly ancient times. Baber (*Memoirs*, 1519, 328), for example, in his description of the citron, compares it with the Musk-melon. There are two primary forms of this plant, one bearing smooth and the other fluted fruits; the former is oblong in shape (***C. moschata*** proper), and the latter a flattened spheroid (***C. melopepo***, *Roxb.*).

Cultivation. Area.

The plant is now widely cultivated in both hemispheres and requires a warmer climate than either ***C. maxima*** or ***C. Pepo***. It is grown as a field crop in Northern India, and the yellow flesh is extensively cooked and eaten as a vegetable throughout India. There appears to be a small form, about the size of a turnip, which is grown under the names *tendús* (Bignor), *tendú* (Duab), *tindú* (Panjáb), and which makes a delicious vegetable when young or half ripe. This is mentioned in the *Ain-i-Akbari* (1590, *l.c.* 66) as a sweet fruit.

C. Pepo, *Linn.; Fl. Br. Ind.*, ii., 622; Taylor, *Topog. Stat. Dacca*, 1840, 139–40; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 170; Sen, *Rept. Agri. Stat. Dacca*, 1889, 46; Duthie and Fuller, *l.c.* i., 377. The Pumpkin, White-gourd, Vegetable Marrow (*var. ovifera*), *kumra* or *kúmara, safed kaddú, lanka, kaula, kohala, petha, bhunga*, etc.

D.E.P., ii., 641–2. Pumpkin.

Leaves 5-palmate, sinus broad and segment pointed; petiole as long as the blade, the hairs of the lower surface hardened into prickles; corolla narrow towards the base and lobes erect; calyx-segments linear lanceolate; fruiting peduncle woody, strongly grooved, and marked with ridges.

The *kumra* is mentioned in many of the ancient Sanskrit works, but ***C. Pepo*** and ***Benincasa cerifera*** were possibly confused or not distinguished. The Pumpkin is often mentioned as a native of America, though this opinion rests on Lindheimer's observation "apparently indigenous." Asa Gray (*l.c.* 333), commenting on that, says "no wild specimen has since been received from all that region (nor from any other)." It is grown in vegetable gardens throughout the greater part of India, and is often seen scrambling over the cultivators' huts. It is nowhere, however, extensively grown, and rarely as a field crop. The following notes on Indian cultivation are taken mainly from Firminger (*l.c.* 171):—In *South India* the improved custard and patty-pan marrows are delicious vegetables, but they only succeed when sown in the early rains. They should be sown in boxes or pans at the end of May. When the first pair of rough leaves appear the seedlings may be transplanted into richly manured pits, at 5 feet apart, in the kitchen garden. The hardier long-fruited varieties will succeed all through the rainy season. In *Lower Bengal* the seeds should be sown in the open ground about the end of October to middle of December, and the plants must have plenty of space to trail over. The best plan is to sow two or three seeds in pits 16 inches deep and as many wide, filled with richly manured soil. If many seeds germinate, eliminate all except one. When the plants have formed about four of their rough leaves they will almost certainly be attacked by a red beetle, but if they can be preserved at this stage they do not seem to be liable to attack later. When they have set as many fruits as the vines will bear the flowers should be removed. The plants require constant and copious watering, and occasionally with liquid manure. The gourds must be gathered when tender, say in May–June, as they rapidly become hard and woody. Both Taylor and Sen speak of the pumpkin as a garden and field crop characteristic of certain parts of Bengal. In the *United Provinces* the sowing of the seed must not be made before the end of February as the plants will not live in the cold season in that part of India. On the hills, sow in April and the vegetable will be in season in July. Duthie says that in these provinces it is a garden, not a field crop. From Mussourie a scarlet pumpkin has recently been reported as brought originally from Kashmir. [*Cf. Journ. Agri.-Hort. Soc. Ind.*, 1902, xii., 116–7.]

Cultivation.

As a field crop in Europe and America the pumpkin and vegetable marrow are grown 15 feet apart with 12 feet between the rows. Three seeds are deposited in each spot, and 2 lb. per acre will therefore suffice. The yield on rich, well-manured vegetable soil is from 15 to 20 tons an acre. In India the seeds are preserved; they yield a clear edible oil, supposed to be of medicinal value. The use of the fruit as a vegetable is of course well known, and the raw fruit is said to be an excellent food for cows. The fruits of several species of melon, gourd, etc., are candied and sold all over India both as a luxury and in medicine. Similarly the seeds of these fruits are largely used for flavouring certain preparations of Indian hemp, and the root for a nefarious purpose, viz. to make the preparation more potent (*Rept. Ind. Hemp. Drugs Comm.*, iv., 425, 491). [*Cf. Produce World*, Feb. 1896; *Planting Opinion*, Feb. 5, 1898; *Journ. Soc. Chem. Indust.*, 1901, xx., 1003; *Pharm. Journ.*, 1901, 67, 253; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 369–70.]

Oil.

D.E.P., ii., 642–5.

CUMINUM CYMINUM, *Linn.*; *Fl. Br. Ind.*, ii., 718; *Pharmacog. Ind.*, ii., 113–6; Duthie and Fuller, *Field and Garden Crops*, pt. iii., 40; Duthie, *Fl. Upper Gang. Plain*, i., 397–8; Cooke, *Fl. Pres. Bomb.*, i., 573; UMBELLIFERÆ. Cumin, *zira, jíraka, ajaji, kamún, zírá, ziya*, etc. This plant is more or less cultivated in most provinces of India, except Bengal and Assam. There is, however, fairly conclusive evidence that it is nowhere indigenous, though in several districts it would appear to be so far naturalised as to have been regarded as "wild" even by competent observers.

History.—Considerable confusion exists in Indian publications through the vernacular name *zírá* or *jírá* being given to both cumin and caraway (see **Carum Carui**, pp. 283–4). A similar mistake is made with regard to ***Nigella sativa***, Black Cumin (p. 811). (The authors of the *Pharmacographia Indica* point out that *jírá* or *jírana*, the Sanskrit names for cumin, as well as the Persian *zhireh* or *zireh* and all the Indian vernacular names, appear to be derived from the root *jri* and to allude to the digestive properties of the seeds). The true cumin is generally regarded as a native of Egypt or of the Mediterranean regions, and according to Somler (*Trop. Agrik.*, 1900, ii., 584) the best sort comes from Malta.

The historical records of the use of cumin go back to early times. It was a common flavouring spice during the 17th century in England, as it still is in Germany; it was extensively employed all over mediæval Europe and was known even in the dark ages. With the Greeks its small size originated a proverbial reproach—*kuminopristes* (cumin-skinning). It is referred to in very much the same sense in St. Matthew, xxiii., 23. In Europe, however, it has been displaced to a very great extent by caraway, but is largely used throughout India. The seeds (fruits) afford from 3 to 4 per cent. of an oil which has the sp. gr. of 0·91 to 0·93. The oil is chiefly employed in Europe in the manufacture of liqueurs. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 544–5.] In India considerable importance is still attached to the medicinal properties of cumin, which is held to be astringent and cooling.

Liqueurs.

Medicine.

Trade.—The available information regarding the Indian acreage of this crop and the average yield are unfortunately not sufficient to justify an attempt at estimating the total production and consumption. The United Provinces and the Panjáb are the chief producing provinces. There is a large internal trade. Madras, for example, gets its supplies from Bengal. One of the earliest references to foreign trade in Indian cumin is that given by Milburn (*Or. Comm.*, 1813, i., 136). "The plant," he observes, "which produces these seeds somewhat resembles fennel, and grows in various parts of India, Persia and Egypt; it is an article of trade with Surat. The seed is a kind of caraway . . . they are to be chosen fresh and of a greenish colour. There are several sorts of cumin seeds to be met with, but they are seldom imported from India." At the present day the exports of cumin from India show a steady increase. Thus they were 11,304 cwt., Rs. 2,22,161, in 1899–1900; 17,385 cwt., Rs. 4,03,875, in 1903–4; and 22,308 cwt., Rs. 5,00,535, in 1905–6. The modern traffic is almost exclusively from Bombay and Bengal, and the best customers are Ceylon, the Straits Settlements and British East Africa. The United Kingdom takes only from 20 to 50 cwt. yearly. But there is a considerable import of cumin across the N.W. land frontier and from Red Sea and Persian Gulf ports. The chief trade centres are Jabbalpur, Gujarat, Rutlam and Muscat. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 203; Tavernier, *Travels* (ed. Ball), ii., 20; Birdwood and Foster, *E.I.C. First Letter Book*, 199, 317, 480.]

Production and Trade.

CURCUMA, *Linn.*; *Fl. Br. Ind.*, vi., 209–16; Cooke, *Fl. Pres. Bomb.*, ii., 729–32; Prain, *Beng. Plants*, ii., 1040–2; SCITAMINEÆ.

D.E.P., ii., 652-71.

J. G. Baker has described (in *Fl. Br. Ind.*) twenty-nine species under this genus. Some ten of these are more or less of economic value and two of considerable importance. It may suffice, therefore, to give a few jottings regarding the unimportant economic species, under the present introductory note, and to thus concentrate attention on the two chief plants:—

C. Amada, *Roxb.*, in *As. Res.*, 1810, xi., 341; the Mango-Ginger, *am-haldí*, *ámádá*, etc., which is found wild in Bengal and on the hills, the tubers being used medicinally and as a condiment and vegetable.

Mango-Ginger.

C. aromatica, *Salisb.*; Cooke, *Fl. Pres. Bomb.*, ii., 730; *Pharmacog. Ind.*, iii., 396–8; the wild or Cochin Turmeric, Yellow Zedoary, *jangli-haldi*, *banhaldí*, *ambé* or *rán-halad*, etc. This plant, which is a native of Bengal, is practically a substitute for the true turmeric, and was not distinguished from it by Arabian physicians. Used medicinally by the Hindus in combination with astringents or with bitters and aromatics and exported to Europe for use as a substitute for turmeric in dyeing. It is chiefly grown at Alwaye, north-east of Cochin, and is also collected in Mysore, Wynaad, etc. The unpeeled root fetches Rs. 24 to 25 per candy of 5¼ cwt.

Yellow Zedoary.

C. cæsia, *Roxb.*; the Black Zedoary, *kálá haldí*, is wild and cultivated in Bengal and chiefly used as a cosmetic. It is one of the two *zerumbáds* of modern Persian writers. [*Cf.* Aitchison, *Notes on Prod. W. Afghan. and N.E. Persia*, 15; *Pharmacog. Ind.*, *l.c.* 403–5.]

Black Zedoary.

C. caulina, *Graham*; the *chavara*, *chowar* of Mahableshwar; **C. leucorrhiza,** *Roxb.*, of Bihar, often specially designated *tikor* or *tikhur*; **C. pseudo-montana,** *Graham*, the *sinderwani* or *sindarbar* of the Konkan; and **C. rubescens,** *Roxb.*, of Bengal, are all said to yield arrowroot that is regularly eaten and which becomes important in times of scarcity or is used to adulterate that of **C. angustifolia.** [*Cf.* Cooke, *l.c.* 730.]

Long and Round Zedoary.

C. Zedoaria, *Rosc.;* Cooke, *l.c.* 732. The long and round Zedoary, *kachúra, sati, shori, zurambád, urúk-el-káfúr, kich-chitick-kizhangu, thanu-wen,* etc. This plant is wild in the Eastern Himalaya and cultivated here and there throughout India. Roxburgh observed that it was a native of Chittagong, whence the Bengal supply was derived. The round zedoary of the shops is greyish-white and compact. It has a bitter and strong camphoraceous taste. The long zedoary has the same odour and flavour. The red powder, *abír,* used by Hindus at the *Holi* festival was formerly largely made from the rhizome of this plant. The powder is purified, dried, and mixed with a decoction of sappan-wood. The rhizomes constitute one of the most important articles of Native perfumery, and a considerable supply is sent from Ceylon to Bombay, the price being about Rs. 20 to 30 per *candy* of 7 cwt. [*Cf. Ain-i-Akbari* (Gladwin, transl.), i., 104; Milburn, *Or. Comm.,* 1813, i., 293; Montgomery Martin, *Hist. E. Ind.,* 1838, iii., 241-2; *Paulus Ægineta* (Adams, Comment.), iii., 434–6; *Pharmacog., l.c.* 399–403; Firminger, *Man. Gard. Ind.* (ed Cameron), 1904, 378–9.]

Indian Arrowroot.
Habitat.

C. angustifolia, *Roxb.; Pharmacog., l.c.* 405-7; Wiesner, *Die Rohst. des Pflanzenr,* i., 612–3. East Indian Arrowroot, Narrow-leaved Turmeric, the *tikhur, tikar, tankír, tavakhíra* (*tavakshiri*), *ararut-ke-gadde, ararút-kishangu, kúra,* etc. A native of the central tracts of India from the mountains of Bengal to Bombay and Madras and, according to some writers, of the N.W. Himalaya as well. It is particularly abundant in the Central Provinces, especially the Upper Godavari district; a considerable trade in the tubers exists at Raipur and Malabar. The arrowroot of the wild tuber is said to be largely prepared and traded in from Cochin and Travancore to Kanara (Malabar arrowroot). [*Cf.* Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 46.]

Wild Tubers.

Planting in Madras.

According to Madras experience the sets are planted late in autumn in properly prepared soil, are watered occasionally during the dry season, and cropped in January. Owing to the dryness of the soil the tubers have, as a rule, to be dug up, not ploughed up, and this process is somewhat tedious. The yield on the prepared soil of the Sydapet Experimental Farm, Madras, was found to be 3,944 lb. of tubers, or 493 lb. of prepared flour per acre. A plot cultivated in the college Experimental Garden yielded at the rate of 7,500 lb. of tubers or 937½ lb. of flour per acre. In preparing the flour, the tubers, after being well washed, are pulped on a grater and the starch and fibre separated by the use of water. It is then strained through a cloth and the fibre thereby separated; the starch is again washed, then sun-dried, and finally broken into fine flour. If sold at 4 annas per lb. the profit per acre would be about Rs. 400. The resulting starch is fine, and the best specimens of it have been even compared to the true arrowroot (**Maranta arundinacea,** p. 773), but the granules are flat and always stratified. Mr. Nibaran Chandra Chodhury in 1901 wrote an instructive note describing the cultivation of this tuber in Bakarganj, which does not, however, differ materially from the Madras experience and results briefly indicated.

Yield.

Preparation of Flour.

Profit.

Cultivation in Bengal.

Trade.

Food for Children.

A fairly large trade exists in *tikhur* or *tankir* arrowroot all over India. It is used as a substitute for ordinary arrowroot, but regarded as less desirable medically. It is, however, a favourite article of food among the Natives, especially for children. The Travancore arrowroot is reported to be not infrequently mixed with the starch of cassava or tapioca (**Manihot utilissima,** p. 766). In Upper India it is said the starch of the sweet potato is sometimes employed as an adulterant, and in Bombay the colourless young tubers of the ordinary turmeric are mixed with those of this plant. Of the trade, though known to be extensive, no details are available. In Bombay, Malabar arrowroot is said to fetch from Rs. 3 to Rs. 4 per maund of 28 lb.

Adulterants.

Price.

The late Dr. Lisboa (*Notes on Mahableshwar and Other Indian Arrowroot-yielding Pl.* in *Journ. Bomb. Nat. Hist. Soc.,* 1887, ii., 140–7) gives much useful information regarding this arrowroot. He would appear to think that much of the East Indian Arrowroot of Western India (especially that of Mahableshwar) is derived from the tubers of **Hitchenia caulina,** *Baker.* [*Cf.* Cooke, *Fl. Pres. Bomb.* ii., 728.] He then mentions as substitutes and adulterants to the true arrowroot, in addition to ***Curcuma angusitfolia*** and ***C. pseudo-montana***, the following :—***Arisæma tortuosum***, *Schott.*, and ***Tacca pinnatifida***, *Forst.*

C. longa, *Linn.; Fl. Br. Ind.*, vi., 214; Duthie and Fuller, *Field and Garden Crops*, pt. iii., 41, t. lxxvii.; Nicholls, *Textbook Trop. Agri.*, 248–9; Mollison, *Textbook Ind. Agri.*, iii., 186; Mukerji, *Handbook Ind. Agri.*, 1901, 359; Cooke, *Fl. Pres. Bomb.*, ii., 732. Turmeric, *haldí, hallde, halada, halud, halja, manjal, pasupu, mannal, arishina* or *arshana, kahá, sanœ, hsa-nwen, haridrá* (Sanskrit = yellow-wood), and *karkōm* (the Hebrew from which *kurkum* and Curcuma have been derived), (Lacaita, *Appendix in* Maw, *The Genus Crocus*, 1886, v.–xiii.), etc. Turmeric is regarded by some botanists as a native of India, but the finest qualities were introduced from China or Cochin-China.

D.E.P.,
ii., 659–69.
Turmeric.

History and Races.—Ibn Baithar (1200, ii., 370), quoting a writer of the tenth century, says that the Persians call this root *al-hard*, and the inhabitants of Basra name it *al-kurkum* or saffron. Garcia de Orta (*Coll.*, 1563, xviii.) gives its chief Indian names, and says that while abundant in Cananor and Calicut, it is only known in Persia and Arabia as obtained from India. He speaks of it as a form of saffron known to the Arabs as *habet*. The *Ain-i-Akbari* gives the prices of the qualities of turmeric, so that it was possibly as well known in India in 1590 as it is to-day. The plant is nowadays extensively cultivated all over India for the sake of its rhizomes. There are two main conditions: one in which a fairly soft rhizome is used as a condiment, being one of the indispensable ingredients in curries; the other in which the rhizome is harder and much richer in colour, hence employed for dyeing purposes. Certain qualities of the rhizome are also fairly largely prescribed in medicine. So very different are some of the so-called forms of turmeric that it has often been urged they must be produced from botanically distinct varieties, if not species, quite independently of ***C. longa***. In European trade, for example, there are known the following :—China, Madras, Cochin, Bengal and Java. The first mentioned is the best. Cochin turmeric is a globular tuber, and usually appears in market cut into slices. It is an edible tuber, and is possibly to some extent often ***C. angustifolia*** or ***C. pseudo-montana*** rather than ***C. longa***. But according to some writers the special qualities of the dye rhizome are more a question of age than of specific distinctions. If left in the soil for a longer period, or if dried and stored for some time before being used, the tubers assume the dye condition. There are, however, special dye stocks known as *lok-handi-haladi, mœla-haldi, jowala-haldi* and *amba-haldi*. These, very possibly, have been produced by the careful selection of centuries of cultivation. The vernacular names of indigenous turmeric could easily have been transferred to an imported plant, just as the foreign arrowroot is displacing the indigenous.

Two Forms:
(*a*) Condiment.
(*b*) Dye.

Grades in Trade.

Cochin.

Qualities of Dye.

Ancient Cultivation.

Cultivation.—1. ***Bengal.***—The description of cultivation in *Bengal* given by Roxburgh is held by most writers to be in the main applicable to the greater part of India. It may, therefore, be quoted here in full. "The ground," he says, "must be rich, friable and so high as not to overflow during the rainy season such as the Bengalese about Calcutta call *danga*. It is often planted on land where sugar-cane grew the preceding year, and is deemed a meliorating crop. The soil must be well ploughed and cleared of weeds, etc. It is then raised in April and May, according as the rains begin to fall, into ridges, 9 or 10 inches high and 18 or 20 broad, with intervening trenches 9 or 10 inches broad. The cuttings or sets, viz. small portions of the fresh root, are planted on the tops of the ridges, at about 18 inches or 2 feet asunder. One acre requires about 900 such sets, and yields in December and January about 2,000 lb. weight of the fresh root." From more recent publications it may be learned that in Bengal two varieties are grown, the *deshi* or country and the Patna; the latter is of a richer colour and gives a better outturn. The crop is often lifted the first year, but the produce is inferior both in quality and quantity to that obtained when left in the soil for a year

Bengal.

Soil.

Planting.

Two Forms Grown.

Twelve to Twenty-one Months' Crop.

Cost of Cultivation.
Yield.
Cuttack Cultivation.
Three Kinds.
Five Years' Crop.

and nine months. The cost of cultivation, which is in the main the same as that of ginger (*Zingiber officinale*), is estimated at from Rs. 7 to Rs. 15 per *bigha* (one-third of an acre), and the yield is variously stated at from 8 to 18 maunds. The former estimate (8 maunds) appears to refer to dried roots. Another estimate for Bengal (*Ind. Planter,* Feb. 14, 1903) gives the cost of planting one *bigha* as Rs. 22-8-0, and the net profit -allowing 16 maunds of fresh turmeric to the acre) as Rs. 25-8-0. Banerjei (*Agri. Cuttack*, 1893, 102-3) speaks of Cuttack having three locally grown roots, collectively designated country turmeric, and one imported from the Tributary States known as *kuarpuria*. Of the local forms *dhanna* is most highly prized for its flavour, and like the *gangakuria* is long in shape, while the *hadua* is round. The last mentioned is strongly flavoured and discarded for cooking purposes. The *kuarpuria* is said to be often left in the fields for five years before being dug up, and is sometimes manured with buffalo-blood. Mukerji says the outturn of turmeric boiled and dried comes to about 16 maunds per acre and of fresh ginger about 50 maunds, but as much as 150 maunds have been sometimes obtained.

U. Prov.
Kumaon and Garhwal.
Seasons.
Cost.
Yield

2. ***United Provinces.***—In these provinces the crop is very extensively cultivated in Kumaon and Garhwal and constitutes an important article of export from the lower hills. It is grown in jungles where nothing else can be raised, as well as in the open Duns and Bhabar. It is planted in April-May and gathered in November. The cost of cultivation is calculated in Kumaon at Rs. 36 per acre, the crop being worth Rs. 75. In the Cawnpore district it is grown with *ghuián* (***Colocasia antiquorum***) and requires abundant irrigation. It is planted in June and gathered in January, the yield being 2,000 lb. fresh roots to the acre.

Panjab.
Six Months' Crop.

3. ***Panjáb.***—Turmeric is not often cultivated in this province, though in the Kangra district it is considered quite as remunerative as sugar-cane, and in addition only occupies the soil six months (May-June to October-November). It requires much care and a liberal supply of manure.

Bombay.
Soils.
Immunity.
Yield.
Profit.

4. ***Bombay.*** Mollison (*l.c.* 186) observes that there are two forms, the hard, highly coloured rhizome, used as a dye, and the large, soft, pale-coloured edible root. Turmeric, he says, does best in the medium black soil of the Deccan, especially where naturally well drained. In Gujarat, on garden lands, it is rotated with sugar-cane, ginger, onions, garlic, etc., or (as a subordinate crop) with ginger. Where mixed with yams it is the chief crop, and about 1,800 to 2,000 lb. of turmeric with 600 to 700 lb. of yams are required to plant an acre. If planted in May the crop may be collected in December-February, but neither the turmeric nor the yams are damaged by being left in the field after maturity till convenient, since in the Bombay Presidency turmeric enjoys a practical immunity from disease. Two crop-tests (1896) in Surat, of mixed turmeric and yam, gave an average to the acre of 14,200 lb. (127 cwt.) of green turmeric, worth about Rs. 1 per 60 lb., and the cost of cultivation per acre Rs. 159-8-0, thus leaving a net profit of about Rs.77 an acre, with the yams over and above.

Madras.
Seasons.
Cost.
Yield.

5. ***Madras.***—In Coimbatore it is said that turmeric is grown with yams, maize, castor, *brinjal*, etc., the rhizomes being planted on ridges in June-July and dug up in March-April. As a rule turmeric is not grown more than once in three years and is followed by *rági* and *paddy*. The cost of cultivation seems to be about Rs. 116 per acre and the produce from 3,000 to 5,000 lb. of prepared turmeric (value Rs. 120 to Rs. 200) and of yams 6,250 lb. (value about Rs. 200), but the actual yield of each crop

when grown together is probably much less. Of North Arcot, A. F. Cox (*Man. N. Arcot*, 1895, i., 276–7) says that the plant occupies the ground for nearly a year. Ten maunds are sown to an acre and the yield is about 200 maunds. When prepared as a condiment the root is called *kari manjal* (Tamil) and *kura pasupu* (Telegu), and when prepared as a dye it is *saya manjal* and *saya pasupu*. Buchanan-Hamilton (*Journ. Mysore, etc.*, 1807, i., 328–9 ; ii., 450, 469 ; iii., 85–6) gives a full account of the cultivation witnessed by him.

Twelve Months' Crop. Seed and Yield.

Mysore.

The above review has been deemed desirable since no single person has studied province by province the production and yield of turmeric. It may have been observed that the yield per acre and the duration of the crop are matters of the greatest obscurity. This seems due to various sources of error : it is often a mixed crop ; the returns are given in maunds, a measure that may vary from 82 to 25 lb. ; it is often not possible to discover whether the figures mentioned refer to dry or green tubers ; and lastly, ignorance regarding the races of plant grown. It is difficult to believe that soil or difference in methods of cultivation could account for a range of from 15 to 262 cwt. per acre.

Sources of Error.

Preparation of the Rhizome.—Various systems of preparing the rhizomes for market appear to be in vogue. In Bengal they are cleaned, stripped of the fibrous roots and heated gradually in earthen pots, the mouths of which are carefully closed by lids fastened with cowdung. The rhizomes are thus stewed in their own juice and freed thereby of the raw smell. Afterwards they are dried in the sun, for nearly a week, being protected at night from dew. In some localities (especially Madras) the rhizomes are boiled in water, to which a little cowdung has been directly added, this practice being believed to protect the tubers against insects. In the United Provinces the bazár-turmeric is prepared by boiling and drying in the sun. In the Kumaon district the prepared roots are soaked in lime-juice and water instead of being boiled anew. In the Panjáb the drying is done by artificial heat.

Preparation for Market.

Bengal System.

Rhizomes are stewed.

Sun-dried.

Madras System.

Boiled, then dried.

U. Prov. System.

Kumaon System.

Soaked in Lime-juice.

Uses of the Turmeric.—When intended to be used as a dye the rhizomes are boiled a second time, powdered while still wet, and a decoction made of this paste with water. The history and properties of turmeric DYE have been very fully dealt with in the *Dictionary* and it is unnecessary to repeat the details here, though desirable perhaps to invite attention to recent publications. Formerly turmeric dye was very largely used in India at marriage ceremonies, etc., but this practice has considerably declined of late. On ceremonial occasions it was also largely employed to rub on the skin, and is so used to this day. [*Cf.* N. N. Banerjei, *Monog. Dyes Beng.*, 1896, 15–6.] The dye is cheap, easily prepared and easily removed, but these conditions are also even more characteristic of aniline dyes, which consequently largely replace the old vegetable dyes. The principal use of the dye in India at the present day is as an auxiliary to such other dyes as *al*-dye (***Morinda tinctoria***), safflower (***Carthamus***), lac dye (***Tachardia***), etc., etc., and in the production of shades of green along with indigo. It is still fairly largely employed in calico-printing and in the coloration of Native-made paper. In *Bengal* it is extensively employed in dyeing cotton clothes, toys and other articles of *sola* pith (**Æschynomene aspera**, pp. 29–30). In the *United Provinces* it is said to be more commonly used as a condiment than as a dye, and is as a rule grown along with ***Colocasia antiquorum*** (*Hadi, Monog. Dyes, U. Prov.*, 1896, 77).

Dye.

Auxiliary to Other Dyes.

Mordants.
Clearing-acids.
India Test-paper.
Medicine.
Food.

Mordants are rarely required with turmeric since the dye attaches itself readily to wool, silk or cotton. Calcutta dyers, however, obtain a brilliant yellow by mixing turmeric with *sajji matti* (carbonate of soda, p. 51). The use of borax (see p. 172) in Kumaon is dependent on an important chemical feature of the dye. The dye is fleeting, but Fawcett (*Monog. Dyes, Bomb.*, 1896, 16) says that the colour can be made more or less fast by adding to the alum solution a preparation of pomegranate rind. The use of vegetable acids to clear dyes is common all over India, and these are often spoken of as making them permanent, though that is not so. Thus, for example, Duncan (*Monog. Dyes Assam*, 1896, 22-3) observes that in Cachar a light yellow dye is produced by boiling turmeric with a "sour lemon-like fruit called *thaikar*." Alkalis deepen the colour, making it almost red, while alum purifies it. For this reason a common test in India for alkalis is paper saturated with an alcoholic solution of turmeric. The action of the alkalis turns the paper brown. In Europe turmeric is still employed in dyeing compound shades of wool, usually in conjunction with *orchil* (a purple lichen-dye from ***Roccella tinctoria***) and indigo extract. It is rarely used on silk (Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 1901, 339). Lastly, turmeric is said to be employed in the adulteration of mustard and to colour varnishes. For the uses of turmeric in MEDICINE the reader is referred to the *Dictionary* or to the *Pharmacographia Indica*, (iii., 407-14), where also will be found a long discussion of the Indian ceremonial utilisations of the dye. As a FOOD adjunct turmeric is chiefly employed in curries, of which it is an indispensable ingredient, and in colouring food-stuffs, etc. The leaves are used as a condiment, especially with fish, which are wrapped up in them and then fried.

The reader will find much useful information regarding commercial turmeric in Hanausek's *Microscopy of Technical Products* (Winton and Barber, transl., 1907, 262-6), the appearance under the microscope of the various grades, their adulterants, and methods of examination of the same being fully exemplified.

Trade.
Satara District.

Production and Trade.—Recent returns do not show the total area under this crop. Mollison speaks of 5,300 acres as the Bombay portion in 1898, and the official statistics for 1905-6 show the area to have been 5,581 acres, of which 4,414 acres were in Satara district alone. Some years ago the total for all India was estimated at 56,500 acres, but the extensive use of the tuber and the remunerative character of the crop would suggest that the total Indian acreage may be considerably larger than that mentioned, though, as stated, it is impossible to furnish the exact acreage.

Exports.
Countries to which exported
Local Traffic.

The exports of turmeric to foreign countries show considerable fluctuations. Milburn (*Or. Comm.*, ii., 542-3) gives the imports into England by the East India Company in 1805 as having been 422 cwt., valued at £1,052, and the duty £2 16*s.* per cwt. The EXPORTS from India amounted in 1899-1900 to 48,000 cwt., valued at Rs. 5,78,199. In 1901-2 the figures were 82,436 cwt. and Rs. 9,40,215; in the following year they rose again to 126,076 cwt. and Rs. 9,87,577; but sank in 1903-4 to 68,234 cwt. and Rs. 4,52,653; in 1906-7 to 62,216 cwt. and Rs. 7,08,967. The bulk of the trade goes to the United Kingdom, the Straits Settlements, Aden, Ceylon, Germany, Arabia, Persia and Turkey-in-Asia. Of the foreign traffic Bombay contributed 33,477 cwt. in 1906-7; Madras 16,231; and Bengal 11,988, but ordinarily Madras supplies more than Bombay. The total amount of turmeric exported coastwise in 1903-4

Madras Chief Source.

was 121,540 cwt., valued at Rs. 9,15,556, of which Bengal took 53,308 cwt. and Bombay 43,661 cwt.; the coastwise exports, however, have since fallen to 63,122 cwt. in 1905–6. The Bengal supply came from Madras and the Bombay from ports within its own presidency. Madras is thus the presidency most concerned in the external supply, and Bengal the most dependent of all Indian provinces on external production. The total traffic by rail and river was in 1906–7, 641,662 cwt., against 526,009 cwt. in 1904–5. The chief distributing provinces are usually Madras, Bombay and Bengal, and of the ports, Calcutta followed by Bombay are those most concerned. But the rail-borne traffic from Calcutta is a direct consequence of the large receipts by sea from Madras.

Commercial Qualities.

With regard to commercial qualities, Semler (*Trop. Agrik.*, 1900, ii., 639) says that the best turmeric is considered to be the Chinese, especially Formosan; the next the Indian, produced in Bengal, Pegu, and Madras; whilst Bombay and Sind afford the worst qualities. As a rule turmeric is sold in Europe in powder-form, but if the solid be desired, the rhizome-fingers should be chosen big, hard, heavy and difficult to break, deep-coloured, with warm aromatic taste and a distinct aromatic effluvia. In these directions for selection, Semler practically repeats the advice given by Milburn in 1813 (*l.c.* 542), but it is possible they are quite applicable to the modern trade. The price on the European markets varies from 12*s.* to 26*s.* per cwt.

[*Cf.* Montgomery Martin, *Hist. Antiq., etc.*, 1838, ii., 834–5; Taylor, *Topog. Stat. Dacca,* 1840, 139; *Journ. Soc. Chem. Indust.*, 1895, xiv., 1079; Woodrow, *Gard. Ind.*, 1899, 479–80; Russell, *Monog. Dyes, C. Prov.*, 11–5; Holder, *Madras*, 3; Giles, *Note on Karini Dyes*; Andrews, *Ind. Text. Journ.*, viii., 59; Hurst, *Silk Dyeing and Printing*, 84; Dutt, *Mat. Med. Hind.*, 1900, 255–6; Thorpe, *Dict. Appl. Chem.*, 1900, iii., 386–9; Allen, *Comm. Or. Anal.*, iii., 458–61; *Soc. Chem. Indust.*, 1902, xxi., 1559–60; Greenish, *Micro. Exam. of Foods and Drugs*, 1903, 286–7; Joret, *Les Pl. dans L'Antiq.*, 1904, ii., 265; Blyth, *Foods, Their Comp. and Anal.*, 74, 86–7, 141, 490; Leach, *Food Inspection, etc.*, 1905, 350–3; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 262–6.]

D.E.P., ii., 673–4.
Cluster-bean.

CYAMOPSIS PSORALIOIDES, *DC.*; *Fl. Br. Ind.*, ii., 92; Duthie and Fuller, *Field and Garden Crops*, pt. ii., 24–5, pl. xxxv; Church, *Food-Grains of Ind.*, 124; Mollison, *Textbook Ind. Agri.*, iii., 84–5; Duthie, *Fl. Upper Gang. Plain*, i., 247–8; Cooke, *Fl. Pres. Bomb.*, i., 308; LEGUMINOSÆ. The Cluster-bean, *guár, gauri, guvar, kuwára, kauri, kachhur, khurti, dararhi, mutki, buru raher, pai-pázoon.* A robust annual pulse cultivated in many parts of India from the Himalaya to the Western Peninsula, and never found truly wild in any part of India.

Varieties.
Shade Plant.
Vegetable.
Fodder.

Mollison mentions three forms met with in Kaira and Baroda Territory, viz. (1) *pardeshi,* sown sparsely amongst *kharif* cereals; (2) *sotia guvár,* growing eight to ten feet high and sown extensively in Gujarat. It is raised as a shade plant to ginger and the leaves are left on the ground as green manure; in the garden lands of Surat it is grown with cucumbers, being planted in May and irrigated till the rains. The pods are used as a vegetable and served like French beans; (3) *deshi,* the common form with violet seeds, sown as an ordinary dry crop and extensively used as cattle-fodder. Duthie and Fuller mention a form known as *deoband kawára,* which is often cultivated in the United Provinces as a hedge or shade plant. They observe also that when the plant is cultivated as a vegetable it is grown on highly manured land near villages, but when raised for cattle-fodder is cultivated on light sandy soils. It is sown at the commencement of the rains and cut in October. The average yield of dry pulse is about 10 maunds to the acre. *Guár* is specially suitable as a green manure or green fodder crop owing to the amount of nitrogen it contains and its comparative freedom (when young) from fibre. Church gives the nutrient ratio

Green Manure.

of the dry beans as 1:1·7, and the nutrient value 79. In certain districts, such as Meerut, where this plant is regularly and largely grown as cattle food, the breed of animals met with is remarkably fine—a high testimony to the care taken of them.

D.E.P., i., 244-52.

CYMBOPOGON, *Spreng.*, *Pl. Min. Cogn. Pugil.*, 1815, ii., 14; *Andropogon*, *Linn.*, *subgen. Cymbopogon*, *Benth. & Hook.*, *Gen. Pl.*, iii., pt. 2, 1133; Hack., in DC., *Monog. Phaner.*, 1889, vi., 592; *Fl. Br. Ind.*, vii., 202-10; Stapf, *Kew Bull.*, 1906, 302-64; GRAMINEÆ.

I have decided to retain ***Cymbopogon*** as a separate genus instead of placing it under ***Andropogon,*** but I confess to being influenced more by industrial than botanical considerations. While engaged writing the brief account that follows, of the Indian economic species, certain specimens were received at Kew, which necessitated a re-examination of the genus or rather the sub-genus ***Cymbopogon.*** Dr. O. Stapf entered on this study energetically, and his report which has since appeared deals with the botanical aspects more thoroughly than can be attempted in this work. He has, however, most obligingly permitted me to consult him freely, and has done me the favour to read through the brief abstract of the subject here given, and to offer useful suggestions. It may be said that the practical result of his studies is the definite establishment botanically of the plant that yields the Lemon-grass Oil of India as distinct from the Citronella Oil of Ceylon.

Economic Species.

The present may be described as a genus of grasses that contains some forty species, widely dispersed in the tropics, principally of the Old World, rare in the temperate regions, as also in America. The species that are of chief economic value are aromatic, but it would almost seem as if that property had been acquired, or rather was dependent on environment for its existence or its intensity. There are four essential oils recognised by the chemist and in trade. These are Palmarosa (Rusa), Citronella, Lemon-grass, and Ginger-grass Oils. While that is so, a few writers have affirmed that these are not necessarily the produce of separate plants, but may be a consequence of climate and soil or of methods of cultivation and seasons of collection, or systems of preparation if not even degrees of adulteration. It is certainly the case that a species or variety that will yield the oil for which it is noted in one region, may not do so (or only to a very small extent) in another.

Influence of Cultivation.

But while environment doubtless exercises a powerful influence, it seems certain that the properties recognised by the chemist can alone be secured by the cultivation of particular forms that are known to yield these. It accordingly follows that the selection of stock with this (as with all other cultivated plants) becomes a question of supreme importance.

Distribution.

In India one or more species of ***Cymbopogon*** occur from the extreme north in Afghanistan, Baltistan, Tibet and Sikkim, to the extreme south at Cape Comorin. And what is more surprising, some of the forms are dispersed from the tropical plains to the temperate alps.

Edible Grass.

One exists in the vegetable gardens of the well-to-do from one end of India to the other (a few roots, at most, in each garden), the leaves being plucked and used in cookery (Firminger, *Man. Gard. Ind.*, 322). That particular plant appears, however, to flower very rarely, and it has accordingly not as yet been satisfactorily described. In the *Dictionary* I assumed, as others had done, that ***Andropogon citratus***, DC., might be the Indian garden plant. The name ***citratus*** suited its properties and popular reputation. De Candolle has nowhere, however, described the plant to which he gave that name, but Nees (*Allg. Gartenzeit.*, 1835, 265) accepted ***A. citratus***, DC. Recently a fairly extended cultivation of what is spoken of as Lemon Grass has taken place in Travancore and Cochin. The oil obtained from that plant has been pronounced different from and very much superior to either the citronella of Ceylon or the rusa of the Deccan. The rapidly expanding trade in this Cochin oil has caused an inquiry to be instituted with a view to extending its cultivation in the West Indies. The oft-repeated statement that it exists in India both "wild and cultivated" is, however, distinctly misleading. In Ceylon ***C. Nardus*** might be spoken of as systematically cultivated, but there is no production of it in India for commercial purposes.

CYMBOPOGON MARTINI
Rusa Oil
D.E.P., i., 249–52.

C. Martini, *Stapf, l.c.* 335–41, 359–60; *Andropogon Martini, Roxb.*, and the *A. Schœnanthus* of most recent authors, but not of Linnæus; *Fl. Br. Ind.*, vii., 204–5.

Vernacular Names.

This is the Rusa Oil plant of Northern, Western and Central India, which in European commerce has received various names, such as "Palmarosa," "East Indian Geranium," or simply "Indian-grass Oil," "Nimar Oil," etc., etc., the inferior qualities being sometimes returned as "Ginger-grass Oil." The vernacular names are numerous, but since it seems probable that no form of *C. Nardus* exists as an abundant wild plant on the plains and lower hills of the region where the rusa oil is mainly produced, the names given in that country must be viewed as denoting the present species, except where they may embrace one or other of the forms of *C. Schœnanthus* as well. In South India wild forms of both *C. Nardus* and *C. Schœnanthus* are met with abundantly, and the vernacular names for the grass oils of that portion of India hopelessly confuse the species. It has been suggested that the most general name "*rusa*" or "*rusa-katel*" (abbreviated into "*roshel*" and rose oil) is in reality a corruption from "rose," seeing that the most important use of the oil is the adulteration or fabrication of rose oil. But as opposed to that view it may be mentioned that until very recently (if not even to-day) the people of India were not aware that the oil they sell goes mainly to Turkey to be used in admixture with rose oil. The most general names are—*rusa, rosa, rauns, rhausa, rhaunsa, roinsa, roshagavat, rohish*, also *gundhabena, mirchiagand, mircha, makora, gandi, panni, chipara bhor, tikhari, tikadi-moti*, etc. According to Dutt (*Mat. Med. Hind.*, 271) and the authors of the *Pharmacographia Indica* (*l.c.* 557), it is *bhustrina, bhutrina* or Earth-grass of the *Raja Nirghanta* and is the *rohisha* of the Sanskrit authors and the *surosa*—the "well flavoured," and the *su-gandha*—the "agreeable odour," of recent classical writers.

Rose Oil.

Sanskrit Names.

Varieties.

Varieties and Races.—It is a perennial grass plentiful throughout the warmer tracts of India. There is no very direct evidence, however, of its being anywhere cultivated, though certain tracts of country are more or less protected and regularly leased out for the supply of the grass employed in the manufacture of the oil. There are six varieties of the species, described in the *Flora of British India*, two of which are Burmese plants not apparently utilised industrially, and a third would appear to be unimportant. Stapf has raised to specific rank the following of these varieties; but while the first mentioned affords the true *rusa* oil, the others may be and in some instances have been used apparently for the same purpose:—

(*a*) **C. Martini,** *Stapf; A. Martini, Roxb., Fl. Ind.*, i., 277; *A. nardoides, Nees* (in part); *A. pachnodes, Trin.*; *A. Schœnanthus, Lisboa, Journ. Bomb. Nat. Hist. Soc.*, 1889, iv., 120.

This is the plant collected by General Martin in Ballaghat, Mysore, in 1791–2 and cultivated by him afterwards at Lucknow. There are specimens of it in the Kew Herbarium from Kashmir, Panjáb hills, Simla, Almorah, Garhwal, Nepal, also the Black Mountains, etc.; of Bengal from Rajmahal and Singhbum; of the Central Provinces, from Chanda district; from Bombay; from Rajputana; and lastly from South India.

(*b*) **C. cæsius,** *Stapf; A. cæsius, Nees* (in part). The majority of the specimens of this form seen by me in the Kew Herbarium came from South India. It is evidently the plant of which Herbert de Jager wrote, in 1683, that he found whole fields fragrant with it when travelling in Coromandel, and of which he found the people of Golconda preparing a perfume.

(c) **C. polyneuros,** *Stapf; A. versicolor, Nees*, in *Wight, Cat.* n. 1705; *Lisboa, l.c.* iv., 120; 1891, vi., 65; *A. polyneuros, Steud.* A South Indian plant, but mention is made of its having been procured from the Central Provinces, and of its existing in Ceylon. A specimen was sent from the Botanic Gardens, Nilgiri hills, with a label bearing the following remark:—"Wild on the grassy hills about Ootacamund and from which species the oil, shown as specimen No. 98, was obtained in Feb. 1902."

Age of Stock.

According to Forsyth (1827) the best *rusa* oil is obtained from the first few cuttings, and an inferior oil from the second crop of the plant. The authors of the *Pharmacographia Indica* (1893, 558) say the grass is called *motiya* when young and of a bluish colour, and *soufiya* when old and red-coloured. This view was also advanced by Lisboa, who speaks of the change from the bluish-green to the red inflorescence as a characteristic feature of the autumn in the country where the grass is at all abundant. It would thus seem that certain authors often uphold the opinion that the variety ***cæsius*** is but the autumn condition of the variety ***Martini***, or perhaps rather that ***cæsius*** is the less robust condition found on dry soils as well as the autumn growth of ***Martini***. In part support of that view I would point out that while many writers, including the original discoverer of the plant, speak of it as found on the dry hillsides, others repudiate that statement and say it is met with only in low-lying damp or marshy soils (*Ind. For.*, 1901, xxvii., 602). On the other hand, the strictly botanical view of the above varieties is supported by the author of the *Khandesh Gazetteer* (1880, 23), who says there are two forms which grow freely at Akrani, the one with bluish flowers, called *sophia*, the other with white flowers, called *motia*; the oil from the last fetches the higher price. Duthie had two specimens sent to him by a correspondent in the Central Provinces, who strongly maintained that they were two distinct plants.

Properties.

Reasoning back from the chemical results, it would seem as if the varied qualities of *rusa* oil might all be obtained from one or from more than one variety of ***C. Martini***, but that ***C. Nardus***, while it yields the varying qualities of citronella oil, is not capable of yielding *rusa* oil as well. The assumption that the South Indian cultivators are producing lemon-grass oil from the same plant as that from which they have recently begun to produce palmarosa (*rusa*) oil is, therefore, not correct. And what is even more to the point, the reputation of their lemon-grass oil, as rich in citral, will be destroyed should they take to mixing it with *rusa*. These both afford geraniol, the perfume for which they are valued by the soap manufacturers. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 132.]

To the promising new industry in lemon-grass oil, definite knowledge regarding the individual properties of the plants grown may be said to prepare the way for more rational efforts in production. As already stated, it is essential to enforce recognition of four distinct oils—Citronella, Lemon, Rusa and Ginger-grass, with varying qualities of each, and in consequence to recognise four distinct plants as affording these oils. The present species is that which yields:—

C. Prov.

RUSA OIL. Central Provinces.—The industry of preparing this oil, so far as can be discovered, is a comparatively modern one. No mention is made, in the list of court perfumes used by the Emperor Akbar in 1590, of any form of grass-oil. [*Cf. Ain-i-Akbari* (Blochmann, transl.), 57.] The oldest detailed account of Indian *rusa* would seem to be that written by Forsyth (*Trans. Med. and Phys. Soc. Calc.*, 1827, iii., 213–8) regarding the district of Nimar (Nemaur) of the Central Provinces—hence the trade name of Nimar oil. The grass, he says, is met with in frequent distinct patches in the greatest abundance along the foot of the Vindhya hills in the vicinity of Gaum Ghat, and thirty miles farther west on the tableland of the same range near Nalcha, at which places only he believed it to be prepared to any appreciable extent. By about the latter end of August it begins to bud, and continues to flower in tolerable vigour till the end of October, during which period alone it gives out the oil in sufficient quantity to cover expense and trouble of preparation.

Nimar Oil.

Method of Distillation.

The oil is obtained by distillation. A wrought-iron boiler is fitted over an earthen fireplace and surmounted with a head from which two straight tubes, from five to six feet in length and two inches in diameter, conduct the vapour into a couple of large copper receivers immersed in cold water. At the conclusion of the process the condensed fluid is poured into a large wide-mouthed vessel and permitted to stand for some time, when the oil may be skimmed off the surface with a small spoon.

Collection of Plant.

The plant is cut across when it begins to flower and bound into small bundles or *maniples*, 250 to 300 of which are placed in the boiler and so much water poured over them as to leave a sufficient space for ebullition. The process occupies about six hours, and there is a succession of attendants so that the charge is repeated about four times every twenty-four hours, and about one seer of oil is thus obtained. In passing through the hands of the traders this oil is largely adulterated with gingelly oil.

Expanding Production.

Yie

From the various reports that have been published by the Forest Department it would seem that a great improvement has taken place, with a corresponding expansion of the production, in the Central Provinces. In the Annual Report of that Department for 1903 it is stated that the industry appears to be extending in Nimar, whilst it has been carried to Betul, Hoshangabad, Mandla and Seoni. It is then added that there is no reason why it should not become an important industry. A. D. Bhote gives in the *Indian Forester* (1901, xxvii., 602) an interesting account of the *rusa* oil industry of Hoshangabad. He says that 500 lb. of dry grass yield 2 lb. of pure oil. Schimmel & Co. mention a case where 373 lb. of grass from Khandesh distilled in Bombay gave 1 lb. 5½ oz. of oil.

Bombay.

Khandesh Oil.

Distillation Special Feature.

Redistillation.

Packed in Skins.

Bombay.—The production of this oil was fostered by the Muhammadan rulers of the Deccan, hence Khandesh oil came to be more spoken of than that of Nimar. Some writers in Europe would appear to have thought Nimar and Khandesh were one and the same place. [*Cf.* Sawer, *Odorography*, 46.] Speaking of the Khandesh industry, the *Gazetteer* affords useful particulars. It would seem that the original seat of the industry in that province was Pimpalner, but the manufacture has spread to Nandurbar, Shahada and Taloda. The makers are Muhammadans, who, at the close of the rains (about September), as the grass is maturing, buy it from the Bhils, stack it, and set furnaces on the banks of the brooks where wood and water are plentiful. The distillation pursued is in all essential points the same as that of Nimar, except that when the cauldron which serves as a condenser begins to vibrate, it is removed from the stream, emptied and refixed. The fluid from the condenser is stirred until the oil begins to form. To make very strong oil, the contents of the condenser are redistilled; the oil which forms on the surface is then skimmed off and the distillate used as the water for a fresh charge of the still. The oil is packed in skins and sent over the Kundaibari Pass to Surat or *viâ* Dhulia and Mammad to Bombay.

Berar.

Distillation.

Yield of Oil.

Berar.—While touring in Berar (Ellichpur district in 1894) I devoted some attention to the *rusa* oil manufacture at Muktagiri. Four stills were found by me fitted into a furnace with their condensers submerged in a stream. The plant used was *C. Martini, Stapf*, found on the dry hilly slopes around the distillery. The crop had been cut and stacked, pending the termination of the rains. During the time of my visit in December it was being distilled. The flowering tops had been cut and tied into *pulis* or bundles, each containing from 60 to 80 stalks; five of these were tied into a larger bundle; 20 of these larger bundles were counted as 100. Into the boiler from 230 to 350 *pulis* were placed, and packed transversely. Over this was poured four kerosene tins of water. Each charge was said to yield 3 *chataks*, or one-fifth seer of oil. The distillate (or fluid obtained from the condenser) was decanted on cooling, the water being allowed to strain off slowly, and thrown away, and thus not used a second time as in Khandesh. But before decanting, the owner skimmed off with a feather certain globules of oil that had formed on the surface. This was said to be the finest and most highly valued oil, and though troublesome it was profitable to remove it by itself even although only a few drops were obtained from each distillate. After the greater proportion of the water had been strained off, the mixed oil and water was placed in a clear glass bottle, and, the hand being held against the mouth, it was inverted. The water was then allowed to gradually escape, and the oil thus purified. It is at first dirty brown in colour, but clears as it is kept. According to the estimate made by me on the spot, from the data furnished by the owner of the distillery, the cost of working each still, including labour, rent of land, hire of apparatus, etc., would be Rs. 1-12 and the net profit Rs. 1-10, even were the oil sold pure; but it is largely adulterated with kerosene oil. It is sold at about Rs. 9 a seer (2 lb.) I was told that Jamod, in Akola, had the best name of all the localities in Berar for its *rusa* oil.

Finest Quality.

Purification.

Adulteration.

Madras.

Madras.—Mention has been made in the concluding remarks under ***C. polyneuros*** (above) of a new supply of what would appear palmarosa oil having been organised in South India. But let it be here repeated that Stapf regards that as a distinct species, and, therefore, very possibly the oil may have distinctive properties of its own, though classed in trade as a quality of *rusa* or in some cases of lemon-grass. The subject will be found dealt with more fully below under the trade of lemon-grass—***C. flexuosus.*** Instead of being exported from Cochin along with the lemon-grass oil, this is conveyed to Bombay and shipped from there to Europe and America, in direct competition with the Khandesh and Nimar oils. This has so materially increased the supply that a serious decline in the price paid has taken place. Schimmel & Co. (*Semi-Ann. Rept.*, May 1904, 54) say, "The producing districts have been extended so largely, that it is difficult to arrive at a proper estimate of the market, and it is an extremely difficult matter whether to advise buying at present low prices or not." "An excellent selection of qualities of so-called East Indian geranium and palmarosa oil of the last harvest is available, and is quoted lower than at almost any previous time." It seems fairly certain that the increased production and high-class degree of oils offered is the direct result of the South Indian supply, and of the endeavours of the Forest Department in the Central Provinces.

Consigned to Bombay.

Increased Production of High Quality.

Properties.

Properties and Uses of Rusa.—According to Gildemeister and Hoffmann (*Volatile Oils*, 281-5, 433-4), the chemical examination of Rusa oil led to the discovery of *geraniol*, which is present in good qualities to the extent of 76 to 93 per cent., the greater proportion in a free state. Of *citronella*, if present at all, there are traces only. It is thus an oil widely different from that obtained from ***C. Nardus***, the citronella. It is a light-coloured oil, soluble in three or more parts of 70 per cent. alcohol. Its saponification number lies between 20° and 40°, but after acetylisation between 230° and 270°. It is frequently adulterated with various fatty oils, as also with turpentine and kerosene, which latter lowers the specific gravity while the fatty oils raise it.

Adulterations.

Uses.
Mixed with Rose Oil.

It is chiefly used for admixture with rose oil, and, since it does not solidify by cold, it prevents the crystallisation of the rose oil. Sawer and others tell us that it is redistilled in Paris, and in Turkey is subjected to a special treatment which appears to render it more fit to mix with *atta* of roses without betraying its odour; this consists in shaking it with water acidulated with lemon-juice, and then exposing it to the sun and air. By this process it loses its penetrating after-smell and acquires a pale straw colour. This was originally explained by Mr. Baur of Constantinople. It may, in fact, be said that the traffic in palmarosa oil is very nearly entirely for the production of cheap *atta* of roses, and hence purchasers of that article require to deal with firms that will give a guarantee of its purity, should they desire to possess the expensive *atta* of roses. [*Cf.* Gildemeister and Hoffmann, *l.c.* 433-5.]

Trade in Rusa.

Indian Trade in Rusa.—It has already been stated that the traffic in this oil is mainly to Europe and from Bombay. Formerly it was shipped to Red Sea ports and conveyed by land-routes, mostly *viâ* Cairo to Constantinople and thence to Europe. Hence it came to bear the absurd name (now happily discontinued) of "Turkish Geranium Oil." It is nowadays shipped direct from Bombay to Europe, but in Bombay it is assorted and deposited within large tins or copper vessels of 100 to 200 lb. capacity. These are surrounded by a network of ropes, but are not placed within boxes. It has been estimated by Mr. Bhote and others that the annual exports from Bombay come to something like 50,000 lb. In the modern trade Ellichpur in Berar has become one of the chief towns of Northern India, from which Bombay draws its supplies. But that estimate must very possibly refer to the produce of Bombay and the Central Provinces alone, since the actual exports in 1902-3 were returned at 125,595 lb. The difference is possibly a direct evidence of the immense supplies being nowadays derived from South India. Of these exports, France, Germany, the United Kingdom and the United States are the receiving countries, mentioned in order of importance.

Exports.

Countries to which Consigned.

Prices.

The value of the essential oils exported from Bombay (chiefly rusa oil) was returned as follows:—1899-1900, Rs. 2,78,005; 1900-1, Rs. 3,41,670; 1901-2, Rs. 6,10,783; 1903-4, Rs. 5,38,774; 1906-7, Rs. 3,19,949. At the prices presently ruling, palmarosa oil is sold wholesale at 3*s.* 9½*d.* a pound, and ginger-grass oil at 2*s.* 3*d.*

D.E.P., i., 247-9.

C. Nardus, *Rendle, Welw. Cat. African Pl.*, ii., pt. i., 155; Stapf, *Kew Bull.*, 314-8, 354-5; *Andropogon Nardus, Linn., Fl. Br. Ind.*, vii., 205.

Associated Species.

As recognised by modern botanists this is a protean species, since it has been made to embrace some ten varieites. Stapf has, however, come to the conclusion that it is perhaps more expedient to treat the following as distinct forms: ***C. Nardus,*** *Rendle,* ***C. confertiflorus,*** *Stapf,* ***C. flexuosus,*** *Stapf,* and ***C. citratus,*** *Stapf.* For the purpose of this work it would seem sufficient to group them together, treating the first as more especially the commercial plant. Thus constituted it occurs throughout the hotter parts of India, Burma, the Malay Peninsula and Ceylon, and is distributed to tropical Asia, Africa and Australia. But it would almost seem as if some at least of the better-known oil-yielding forms had (as cultivated plants) originated in the Malaya, since even in Ceylon citronella is admitted to be different from the undoubted indigenous stock. In India no form of ***C. Nardus*** (other than the allied ***C. citratus***) existed until quite recently in a state of systematic cultivation. In any effort at extended production it would, therefore, seem essential that separate attention be given to the forms of this and the allied species as established by Stapf, namely:—

(*a*) **C. Nardus** proper. The Citronella Grass. The first definite account of this grass would appear to be that given by Grimmius (*Laborat. Zeylon.*), an author who died in 1711 but who mentions the oil made from citronella. Stapf remarks that he is unable to distinguish the different kinds of Ceylon citronella, but in his opinion all the cultivated races have been derived from ***C. confertiflorus***, *Stapf.*

Pangiri Maana. This is the *pangiri maana* grass of Ceylon, and is there only known in cultivation. It now seems possible that many of the vernacular names given in the *Dictionary* under this species belong in reality either to the plant given below as ***C. flexuosus*** or to one or other of the forms of ***C. Martini.*** The present plant does not appear to have been known to the Sanskrit, Arabic or Persian medical writers. It owes the botanical name ***Nardus*** very possibly to a confusion. Linnæus assumed (*Mat. Med.*, n. 32) that it was the *nard* of India: it was early known in Europe as *spica indica* or *spigo nardo.* But it is surprising that there is no very distinct early record of the wild plant having been systematically distilled in South India as ***C. Martini*** is in the North, although it is probable that Ainslie may be alluding to it, since botanically the cultivated stock would appear to have been derived from a plant that is wild in South India.

Ceylon. *CITRONELLA Cultivation in Ceylon.*—It is cultivated chiefly in Ceylon and Malacca. Winter (*Chem. and Drugg.*, lii., 646)—one of the largest distillers of citronella oil—says there are two varieties. These are (1) a form known as *lana batu*, which appeared naturally in 1885; and (2) another, known as *maha panigri*, which represents the older stock—a more delicate plant than (1). There is no specimen in the Kew Herbarium specially labelled as *maha pangiri*, but there is one of *lana batu.* This is ***C. Nardus*** proper, but it is attacked by a form of ***Ustilago*** or Smut—a parasitic fungus—that lives within the tissues of the plant throughout its life, and may thus possibly influence materially the yield of the essential oil. This might (if so desired) be completely eradicated by the seed being previously washed in water at a temperature of 120° F. In the Administration Report of the Royal Botanic Gardens, Ceylon, for 1903, mention is made of the appearance of Ergot (***Claviceps***) as a disease on the *maana* grass.

Two Forms.

Diseases.

Propagation. It is said that the *lana batu* is the most widely distributed form of this species and can be produced on soils of a much poorer quality than those required for the *maha pangiri.* The plantation once established needs little attention further than to cut the shoots systematically so as to prevent flowering. There are two seasons, the first and principal in July and August; the second from December to February. The yield averages from 16 to 20 bottles (according to some writers 22 to 28 lb.) per acre for the first crop, and 5 to 10 bottles (7 to 14 lb.) for the second. But with age the plant yields less and less, so that by fifteen years the plantation has to be renewed. The yield also varies greatly with seasonal conditions. In the Ceylon report above mentioned particulars will be found of test experiments on the yield of different forms of the plant, as also different seasons of collection. The variability will be seen to be remarkable, especially the lower yield of the indigenous as compared with the introduced and cultivated forms.

Cutting.

Seasons.

Yield.

Distillation. In Ceylon the distillation is accomplished by direct steam without the addition of water to the grass. A charge of dry grass is distilled in about six hours, and the exhausted grass, after being dried in the sun, is used as the fuel for the works. *Citronellal* is the principal bearer of the citronella

Composition of the Oil.

First Quality.

odour. The *lana batu* variety yields an oil that contains *citronellal* (28·2 per cent.), is relatively poor in *geraniol* (32·9 per cent.), affords *methyl eugenol* (8 per cent.), and has a high specific gravity. It constitutes the bulk of the citronella oil of commerce. The oil of *maha pangiri* contains 50·45 to 55·34 per cent. citronellal, 38·15 to 31·87 per cent. geraniol, and only 0·78 to 0·84 of methyl eugenol. The low percentage of the last-mentioned substance accounts for its low sp. gr. The *maha pangiri* is the first quality, and is often in trade called "Singapore Citronella," while the *lana batu* is the second quality. Citronella is mainly in demand by the soap manufacturers on account of its geraniol, one of the chief constituents of rose oil.

Trade.

Decline in Exports.

Rise in Price.

Singapore.

Trade in Citronella.—The traffic in this oil first attracted attention about 1887, when the exports from Ceylon were returned at 551,706 lb.; in 1890 they became 909,942 lb.; in 1895, 1,182,255 lb.; in 1900, 1,409,056 lb.; in 1901 they stood at 1,430,168 lb.; and recently (1902) suffered a serious decline to 1,294,750 lb.; and in 1903 still further to 1,062,594 lb. But the decline in the production has caused a satisfactory rise in the price from 9*d.* to 1*s.* 2*d.* per lb. Schimmel & Co. say the demand at present exceeds the supply, and that a decline in the price is inconceivable. The oil goes mainly to England, America, Germany and Australia. The industry centres chiefly in the southern parts of Ceylon, where there are said to be 50,000 acres under the crop, and over 600 stills at work. As compared with this the production in Singapore is reported hardly to exceed 30,000 lb., obtained from about 2,000 acres.

Adulteration.

Over production.

Java.

The Ceylon traffic has suffered, however, very greatly through adulteration with kerosene, fixed oils, and more recently alcohol, as also in consequence of overproduction. Of late the vigorous development of the cultivation in Java and the rise of the Travancore industry in lemon-grass oil are circumstances that have operated unfavourably on Ceylon production. Mr. Bamber (the Ceylon Government Chemist) has interested himself in this subject and has invented a process by which the adulteration of the oil that is being exported may be readily and effectively detected. Satisfactory endeavours are being made by the Ceylon Government to improve the methods of production and manufacture presently pursued by the Natives and to discountenance if not to check adulteration.

Malabar or Cochin Grass.

(*b*) **C. flexuosus,** *Stapf.* The Malabar or Cochin Grass. This is the Lemon-grass plant of Travancore. Stapf draws my attention to the fact that an excellent figure of this plant was given by Rheede (*Hort. Mal.*, 1703, xii., 107, t. 57), who calls it *kodi-pullu.* It is the ginger-grass oil (*sukkanaru pillu*) of some writers, such as Ainslie (*Mat. Med.*, ii., 401), spoken of as procured from the Courtallum hills and from Tinnevelly district. It has been distributed by Wight to herbaria under the name *A. flexuosus, Nees* (*Steudel. Syn. Pl. Gram.*, 1855, 388).

Travancore Lemon-grass Oil.

Medicinal Oil.

LEMON-GRASS OIL Cultivation.—Very little of a definite and trustworthy nature has been published of the production of this grass as distinct from several others that are known to be grown. Every writer on the subject of the grass oils of India speaks of LEMON-GRASS OIL as being used by the Natives of India in the treatment of rheumatism and cholera. It seems fairly certain that these passages have little to justify their retention under the present plant except where they make exclusive reference to the extreme South of India, and especially to the Travancore and Malabar oil. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 1900, 285; Wiesner, *Die*

Chief Constituent.
Artificial Perfumes.
Perfumed Soap.
Wild and Cultivated.
Cochin.
Wild Forms.

Rohst. des Pflanzenr., 1903, ii., 577, etc.] But while the greatest possible obscurity has prevailed as to the botany of the Indian lemon-grass oil plant, the chemical identity of the oil has been fully established. It was first made known in 1888 that the most interesting feature of lemon-grass oil was the large percentage of *Citral* that it contained. This has been variously stated at from 70 to 80 per cent., and inferior or adulterated samples 40 to 50 per cent. It is employed in the manufacture of artificial perfumes such as the violet known as *Ionone*, and like all the other grass oils is utilised mainly in perfuming soaps. The demand for lemon-grass oil has increased with surprising rapidity, and given to South India a new industry of considerable promise. The Travancore area may be described as the slopes of the mountains to the north of Anjengo, close to Quilon. It would now appear the plant is both wild and cultivated. The hillsides are said to be fired in January to burn down the old and useless grass. Six months later the fresh crop is ready to be cut: by that time the countryside becomes dotted all over with furnaces and stills. During July, August, September and October operations are continuously maintained, but there would appear to be no second crop. Speaking of the more recent Cochin industry, various public newspapers have afforded a few particulars. Mention is made, for example, of Mr. Barton Wright having leased large tracts of lemon-grass land in Waluvanad and Ernad of Malabar and built a distillery on the most improved plan. The Moplahs are said to recognise twenty-seven forms of the wild plant, of which five only are of commercial value and one is cultivated and never flowers. The wild plants are of necessity forms allied to ***C. Nardus***. Whether they all yield the same oil is doubtful, the more so since the allied form of ***C. Nardus*** all yield perfectly distinct oils.

Trade.
Two Distinct Oils.
Price.
Trivandrum.

Indian Trade in Lemon-grass Oil.—In recent returns we read of a new trade in rusa oil from South India to Bombay. As already explained, that is distilled from a wild plant, possibly ***C. Martini, var. polyneuros***, and unless it be used as an adulterant is perfectly distinct from the lemon-grass. Schimmel & Co. (*Semi-Ann. Rept.*, May 1903, 42), speaking of the lemon-grass oil, say, "It may be taken for granted that this new source of supply will in future form a strong competitor, and that the prices will permanently remain low, which would promote the consumption. At the present values the article will have all the more interest for the soap manufacturers, as the parcels which have appeared on the market were chiefly of such a fine quality as had not been met with last year." It would thus seem certain that the aromatic grasses of South India (like those of Ceylon) yield at least two perfectly distinct oils—rusa and lemon, and that the traffic in lemon-grass has become an important one. This may be indicated by the fact that the wholesale price has increased from about 2*s*. a pound in 1891 to 9*s*. 6*d*. (7½*d*. per ounce) in 1904. The chief commercial centre is said to be Trivandrum, and the exports are made from Cochin and Quilon. In 1891-2 these came to 1,450 cases, in 1896-7 to 3,000 cases; the subsequent years were as follows:—1899-1900, 2,792 cases; 1900-1, 1,933; 1901-2, 2,322 cases; and in 1902-3, 2,807 cases. But according to local reports the outturn of the last-mentioned year came to something like 5,000 cases, each containing twelve bottles of 24-oz. capacity. The statement is frequently made that the price paid for this oil has been forced up to an extent that greatly interferes with increasing demands.

Culinary Lemon-grass

D.E.P., i., 242–4.

(c) **C. citratus**, *Stapf, Kew Bull.*, 1906, 322–30; *Andropogon Schœnanthus, Linn. Syst.* (10th ed.), 1759, 1304, *Sp. Pl.* note; Roxb., *Fl. Ind.*, i., 274–5; Dalz. and Gibs., *Fl. Bomb.*, 1861 (suppl.), 99; *A. citratus, Trim. & Hook.*, *Handbook Fl. Ceyl.*, v., 246; Ridley, *Journ. Roy. As. Soc.* (Straits Branch), 1891, 3. Lemon-grass of Indian vegetable gardens. This is the *oli-cha*, *nili* or *lili-cha*, *hirva-cha* (=green tea), *váshanap-pulla* or *vásana-pillu*, *nimma-gaddi*, *ágya-ghás* or *agin ghás*. The name *cha* (tea) is doubtless Chinese in origin but has been used in India for centuries, and indicates doubtless the use of the leaves as a flavouring ingredient with tea. The employment of such terms denotes, however, recent knowledge—or rather European knowledge of the grass. It is thus the edible lemon-grass or Indian verbena of Europeans.

Stapf informs me that he makes the *sereh* of the kitchen gardens of the Malays, which is identical with the Lemon-grass of Singapore, correspond with the vegetable garden plant of India. It was probably first mentioned by Franc. Martinellus (1604), and the earliest unmistakable description of it was given by Eusebius Nieremberg (*Hist. Nat.*, 1635, lib. xv., ch. 19, 343), who called it *tanglat*, a name still in use in the Philippines. It is next mentioned by Bontius (*Hist. Nat. et. Med. Ind. Or.* in Piso, *Ind. Utri. re Nat. et Med.*, vi., 148), but Herbert de Jager in a letter to Rumphius, published by Valentini (*Hist. Simpl.*, 1732, 392), points out that Bontius was wrong, and that ***Schœnanthus*** does not grow in Java; Jager calls the plant *sire*, and this is apparently the first occurrence of that name. Rumphius, in a letter to D. W. ten Rhyne, also employed the name *siree* but added that it might be called the sterile Indian ***Schœnanthus*** in order to distinguish it from the Arabian (*Herb. Amb.*, v., 181, t. 72, f. 2). Sam Browne (*E. Ind. Pl.* in. *Phil. Trans.*, 1702, xxiii., 1251–2) remarked that this grass was in his day used by the Portuguese women at Fort St. George, but was little esteemed by the Natives. It was met with in gardens near the sea coast, and had been introduced from Batavia about 1666 A.D. Lemon-grass was conveyed to England by Sir Joseph Banks in 1786. Roxburgh gave ***A. Schœnanthus*** the Bengali name of *gandha-bená*, but the description and the drawing made by him leave little doubt that the plant in question was the present variety of ***Nardus***.

Culinary Lemon-grass.—From the observations already made (see p. 450) it may be inferred that hitherto the very greatest possible obscurity has prevailed regarding the botanical sources of the lemon-grass oils of modern commerce. Before having seen Stapf's interesting report I had written that if not a perfectly distinct species (for which the name ***citratus*** had been accepted in the *Dictionary* and might with advantage be continued), the present plant would prove one of the many races of ***C. Nardus***. Apart from the fact that there is a plant widely cultivated in Indian gardens which is generally designated lemon-grass (Lisboa, *Bomb. Grass*, 1896, 87), and that a grass oil (named lemon-grass) is in South India obtained from a wild and apparently distinct plant (see ***C. flexuosus*** above), there is the still further surprising circumstance that the trade recognises "lemon-grass oil" as produced in Ceylon in addition to citronella. [*Cf.* Gildemeister and Hoffmann, *Volatile Oils*, 288–9; *Ann. Rept. Roy. Bot. Gard. Ceylon*, 1903, 15.] It would thus appear that the Ceylon planters have for some time been regularly growing the lemon-grass oil plant.

Malabar and Cochin Grass.

To obviate possible confusion between the edible lemon-grass of India (***C. citratus***) and the lemon-grass oil of Malabar (***C. flexuosus***), Stapf uses for the latter the name Malabar or Cochin grass. Unfortunately, however, lemon-grass oil is by no means exclusively obtained from Malabar, and "lemon-grass" is likely, therefore, to be continued to designate the oil in commerce, irrespective of the local Indian usage mentioned. But has it been proved that the lemon-grass (***C. citratus***) might not itself afford, or that it is not actually affording, an odoriferous oil? It is understood that the lemon-grass oil of Ceylon is less valuable than the lemon-grass oil of Travancore. But has it been definitely proved that both these are obtained from one and the same species, the differences being climatic, not racial? In other words, has it been established beyond dispute that the peculiarities in the grades of lemon-grass oil denote the species of plants used? With such uncertainty it is perhaps permissible to think that at least some of the grades of lemon-grass oil are obtained from the culinary lemon-grass—the *oleum siree* of Lochner (*Ephem. Acad. Nat. Cur. Cent.*, 1717, v–vi., app., 157); and if this be so the name must be retained.

The extraordinary anomaly is thus presented of an important plant, such as ***C. citratus,*** known possibly to a large number of the inhabitants of India and Ceylon, not having been systematically studied. This subject should, therefore, commend itself as worthy of attention to those who may have the opportunity of contributing either new material or fresh information.

Used in Cookery.

Lemon Tea.

Used with Soup.

Rumphius says the leaves were used in cooking fish and in flavouring wine, but he throws doubt on the roots being medicinal. In India as a whole (excluding the modern Travancore and Cochin industry) the CULINARY LEMON-GRASS does not appear to be distilled. Wallich (*Pl. As. Rar.*, 1832, iii., 48, t. 280) under the name ***Andropogon Schœnanthus*** gives an illustration of what is possibly a distinct species but which has by Hackel, followed by Hooker, been treated as ***A. Nardus,*** *Linn., var.* ***grandis,*** and with that East Himalayan plant Wallich has associated the economic information of the garden lemon-grass. He quotes, for example, from Fleming (*As. Res.*, 1810, xi., 156), who says, " Many Europeans with whom tea does not agree, use, instead of it, the infusion of this plant, to which they have given the name of lemon grass." Dr. Wallich then adds, " Dr. Maton, one of the Vice-Presidents of the Linnean Society and Physician Extraordinary to the late Queen Charlotte, tells me that he has repeatedly been treated with a dish of lemon grass tea by Her Majesty, who used to be very fond of it, and was supplied with the plant from the Royal Gardens, Kew." " There are few people," Wallich concludes, " who have experienced the influence of an Indian climate, who have not found benefit from the wholesome and refreshing beverage prepared from this grass." It might almost, however, be said of India, as it can certainly be said of England, that Queen Charlotte's lemon tea has become completely forgotten. The lemon-grass is occasionally added to certain soups or used while cooking fish and curry, but as affording a refreshing beverage it is unknown to the people of India to-day.

Lanowli Scented Oil.

Lastly, in this place mention may be made of Mrs. Lisboa (*Journ. Bomb. Nat. Hist. Soc.*, 1889, iv., 123) having figured and described a new species, viz. ***Cymbopogon odoratus,*** found wild at Lanowli, Poona, which is said to yield an oil " soft, sweet and more agreeable than that of ***C. Martini.***" It is thus evident that even if ***C. citratus*** be excluded from consideration as an odoriferous oil-yielding species, there are very possibly several distinct plants that afford oils, many of which are treated as lemon-grass oils.

[*Cf.* Sawer, *Odorography*, 88–9; *Pharmacog. Ind.*, iii., 567; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 577; *Western Star*, Sept. 1901; *Yearbook of Pharmacy*, 1900, 162; 1901, 55; *Chem. and Drugg.*, 1901, 864; 1903, 507; 1904, 179–82; *Trop. Agrist.*, 1901, 59, 199; 1902, 473; 1904, 531; *Bull. Econ. L'Indo-Chine*, 1902, 867; *Der Tropenpflanzer*, 1902, 196, 425; 1904, 321; *Proc. Chem. Soc.* 1903, xix., No. 273; *Chem. News*, 1904, 21; *Journ. Chem. Soc. Indust.*, 1903, 1305; 1904, 75, 694.]

C. Schœnanthus, *Spreng.* According to Stapf (*l.c.* 303–13, 352) there are at least two fairly distinct plants commonly assigned by authors to *Andropogon Schœnanthus*, *Linn.* These are as follows:—

(*a*) **C. Schœnanthus,** *Spreng., Pl. Pugil.*, 1815, ii., 15; *A. laniger, Desf., Fl. Atlant.*, 1793, ii., 379; *Fl. Br. Ind.*, vii., 203 (in part).

Ginger-grass.

Ginger-grass.—This is the *Schœnus*, *Schœnanthus*, or *Squinanthus*, and to some extent also the *Juncus odoratus*, etc., etc., of Greek and Roman writers, as also of most of the early writers on Materia Medica. An oil prepared from it would appear to be known as GINGER-GRASS. The Oriental names for the plant have been so much confused with the next species (if not with several other species) that it would be a bold step indeed to separate them and to affirm that *izkhir* (Arab.), *gúrgiyah* (Persian) and *bhustrina* (Sansk.) denote this particular species and no other. It follows accordingly that the modern vernaculars of India cannot be arbitrarily separated. In fact it would perhaps be the safest course to call in the aid of geographical distribution and to assign the names in common use for perfume-yielding grasses in the respective areas where the spices abound, as being the names proper to these species. The present form, according to Stapf, is met with "from Morocco to the Panjab and Ladakh." "In the Panjab it is common in some of the desert tracts from Karachi to Peshawar and Ludhiana, growing on rocks, in sand or in hard loamy soil." The Indian vernacular names best known for it within that area are *khavi* and *ghatyari*.

Oil.

It would appear that an oil is actually produced in the Panjáb from this plant, though only very occasionally. In fact the reports that have appeared on the diversified properties of such oils are very possibly due to incorrect determinations of the plants concerned. In a few instances records of oil exist, however, that leave little room for doubt of having been actually obtained from the present species. Edgeworth (*Journ. Linn. Soc.*, 1862, vi., 208) describes under the name *Cymbopogon Ariana* the plant met with in Multan—the country where the Malli resided in the time of Alexander the Great. Stapf has pointed out that on the label of one of his specimens Edgeworth wrote, "An essential oil expressed from the roots, manufactured only at Kasúr in the Panjab." This, adds Stapf, "is probably the same kind of oil which Vigne records from Hassan Abdal (between Attok and Rawalpindi) with these words: "A stimulating oil is extracted and used in medicine." Mr. J. R. Drummond confirms Edgeworth's report by the information communicated to Stapf that a family of priests at Kasúr produced this oil quite recently (see **Rosa**, p. 926).

Used medicinally.

Nard Roots.

It perhaps need hardly be reiterated that the oil in the above passages is spoken of as expressed from the roots, not from the leaves and shoots. The fact of there being a medicinal root, or rather two species of roots—the *nard* of the early explorers of India—known to all modern Indian medical writers is of great historic interest, and the botanical evidence would support belief that when dealing with the Western Panjáb, Sind, Baluchistan and Persia, the plant in question may be accepted as *C. Schœnanthus*, *Linn.*, but when dealing with the Eastern Panjáb and the United Provinces, it is in all probability the species presently to be discussed, viz. *C. Jwarancusa*, *Schult.*

(*b*) **C. Jwarancusa,** *Schult., Mant.*, 1824, ii., 458; *Nardus indicus, Blane, Phil. Trans.*, 1790, lxxx., 234, t. 16, f. 1; *Andropogon Jwarancusa, Jones, As. Res.*, 1795, iv., 109; *A. Ivarancusa, Dierbach, Fl. Apiciana*, 73; *A. Iwarancusa, Roxb.*, *Fl. Ind.*, i., 275–7; Dalz. and Gibs., *Fl. Bomb.*, 1861, 301–2; Lisboa, *Journ. Bomb. Nat. Hist. Soc.*, 1891, vi., 66; also *Bomb. Grass.*, 85; *Andropogon laniger*, *Duthie*, *Fodd. Grass. N. Ind.*, 35–6, t. 23; *Fl. Br. Ind.*, vii., 203 (in part).

Nardus Indicus. ***Sweet-scented Medicinal Grass.***—Of this plant—the *Nardus indicus* of early writers—Stapf observes that it occurs on the outer hill-zone of the United Provinces, Kumaon, Garhwal, and westward as far as Peshawar—mainly in the neighbourhood of watercourses. This is, therefore, a much more abundant Indian form than the preceding. It frequents, as a rule, colder and moister regions. But the name *jwarankusa*, which Stapf treats as Sanskrit, is so in derivation very probably, but was apparently never used by even the most recent of Sanskrit authors as the specific name for this or any other grass. Dutt (*Mat. Med. Hind.*, 1900, 271) gives the Sanskrit name *lamajjaka* as denoting ***A. Iwarancusa***, *Roxb.*—the *lamjak* of Hindi and the *karankusa* of Bengali. But according to him, the ***A. Schœnanthus*** (the *bhustrina*, Sanskrit, and *ganda bena*, Bengali) was the plant we now call ***C. citratus***, so that the Sanskrit and vernacular names above very possibly denoted both ***C. Jwarancusa***, *Schult.*, and ***C. Schœnanthus***, *Linn.* [See **Cyperus rotundus**, p. 466.]

Duthie gives it the following vernacular names (some of which may, however, denote ***C. Schœnanthus***):—*sirghurai*, *solára*, *bur*, *khair*, *gandhi*, *khawi*, *gander*, *runa*, *dabsulo*, *babhori*, *jarámkush*, *azkhir*, *khavi*, *gandel* none can be said to be derived from its supposed Sanskrit name. Roxburgh, who rendered the name *jwarancusa* as *iwarancusa*, gives as its synonyms *ibharankusha*, *iwarankusha*, *karankusha*, and says these are Bengali, but makes no mention of Sanskrit names. So also Dutt accepts *karankusa* as Bengali, but does not give *jwarankusa* as a Sanskrit name. Moreover, Roxburgh very properly observes that as stated by Blane, the virtue of the plant resides entirely in the root. Duthie, speaking doubtless of this grass under ***Andropogon laniger***, *Desf.*, says it is one of the sweet-scented grasses, "the roots of which are sometimes used like *khas-khas* in the manufacture of tatties." "As a fodder grass it does not rank high in regard to its nutritive qualities. It is, however, largely made use of by cattle when it is young and tender. Its scent is said to affect the flavour of their milk. It is often stacked and forms a useful supply in times of scarcity. Mr. Coldstream says that it will keep good in stack for upwards of ten or twelve years." "The *khair* grass grows in hollows where water collects, and seems to prefer *kallar*, that cows graze upon it if hard pressed, but not otherwise; also that *bár* housewives use wisps of this grass to clean out vessels used for churning and holding milk."

Spikenard *versus* Nard. The perfume being chiefly resident in the root, not in the stems and leaves, justifies the association of the *Nard* (perhaps more ***C. Schœnanthus*** than ***C. Jwarancusa***) with the story of the Phœnician followers of the army of Alexander the Great in Lus and of the confusion that long existed regarding the *spikenard* of the ancients. This, doubtless, is the plant spoken of by Pliny and in more recent times by Garcia de Orta as found on the banks of the Ganges.

The preceding observations may be accepted as setting forth the separation of the two forms of *Nard*, both of which industrially have been treated as one plant. It has also been affirmed that the chief property of the plant is its sweetly scented roots. But apparently the leaves and shoots of one or other (or of a third species not separately recognised from them) yields by distillation an oil with slightly different properties from rusa. In some

Perfumed Oil.

Mixed with Rusa.

Ginger-grass Oil.

parts of the country the present plant is more sweetly perfumed than in others, as, for example, in the vicinity of Rawalpindi. Duthie tells us that a "perfume is manufactured from it, and the aromatic oil is sometimes used as a cooling medicine." The authors of the *Pharmacographia Indica* (iii., 558) mention that in the time of the Tuhfat-el-muminin (about 1669 A.D.) a distilled water was made from *izkhir* and apparently the oil of **C. Martini** was then unknown, if the name *izkhir* was not used indiscriminately for **C. Martini** and **C. Schœnanthus.** Indeed it is believed that the variability of *rusa* oil may to some extent be due to this grass being mixed with **C. Martini** and both distilled together, or to the oil of the present plant having been mixed with that of *rusa* (palmarosa). In fact, according to most authors on essential oils, this is very possibly the chief source of some of the "ginger-grass oils" of commerce (Gildemeister and Hoffmann, *Volatile Oils*, 285). If pure it is valued at 2*s*. 3*d*. per lb. Schimmell & Co. say, "Our examinations have proved that it is a pure distillate deserving absolute confidence. Never has this oil been on the market in such fine quality as at present" (*Semi-Ann. Rept.*, 1904, 44–8). Gildemeister and Hoffmann (*l.c.* 300) say it has the sp. gr. of 0·915 at 15° and its odour recalls that of *elemi*. It distils between 170° and 250°. The statement that an oil is not prepared from **C. Iwarancusa** would, therefore, appear incorrect. But the roots and lower stems which constituted the *Schœnanthus* of the ancients would seem not to be collected in India to any material extent at the present time. Garcia de Orta (1563) was the first European writer to refer to that product in connection with India. He tells us that it came from Muscat, was known as "Herba de Mascat," and was used by the Portuguese in India, but not by the Natives. He makes no mention of any of the essential oils derived from this or the allied grasses.

But in spite of the fact that so great an authority as Sir William Jones repudiated hotly Blane's opinion that the *Nardus* of many authors was in reality **C. Iwarancusa**, I am strongly inclined to agree that a too literal acceptance of Jones' view may be misleading and has possibly in the past induced error. Pliny (*Hist. Nat.*, bk. 12, ch. 12 (Holland, transl.), 364) says the "*Nardus* spreadeth into certain spikes and ears whereby it hath a twofold use both as a spike and as a leaf." Apicius speaks of the *spica indica* being used in sauces and costly dishes, but this may have been **C. citratus**—the plant that I have spoken of as the edible lemon-grass. *Paulus Ægineta* (Adams, transl., iii., 265) derived his information mainly from Galen, who draws again on Dioscorides and speaks of it purely as a drug and ointment. It seems highly probable, therefore, that the *Nardus* of the ancients was different from the *Jatamansi* of the Sanskrit authors, though the plant known to botanists as **Nardostachys Jatamansi** doubtless is the *spikenard*. Garcia de Orta (*Coll.*, l.; also in Ball, *Proc. Roy. Ir. Acad.*, 674), followed by most of the older Indian travellers, speaks of the *Nardus* as obtained from the plains of India, and can only be referring to one or two species of **Cymbopogon**, certainly not to the alpine **Nardostachys.**

D.E.P., ii., 678–81.

Dúb-grass.

CYNODON DACTYLON, *Pers.*; *Fl. Br. Ind.*, vii., 288; Bontius, *Hist. Nat. et Med. Ind. Or.* in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 148; Rheede, *Hort. Mal.*, xii., 47; Jones, *As. Res.*, 1795, iv., 248–9, t. 11; Duthie, *Fodd. Grass. N. Ind.*, 52; *Pharmacog. Ind.*, iii., 577–8; Lisboa, *Bomb. Grass.*, 104–6, t. 57; *Rept. Agri. Chem. Mysore State*, 1901–2, 27. Creeping Panic Grass or Doorwa, Bermuda Grass; *dúb*, *daurva*, *júbla*, *kabbar*, *talla*, *buráwa*, *chibbur*, *dhobi-ghás*, *káli ghás*, *hariáli*, *arúgampilla*, etc. A perennial creeping grass which flowers all the year round. Grows everywhere throughout India except perhaps in the sandy parts of Western Panjáb, where it is rare.

Lisboa says this grass is now generally spread in the settled parts of Australia, where it may have been introduced with cultivation. According to Vasey (*Rept. Grasses U.S.*, 1883, 54–6, t. 59) it takes the place in the Southern States of the famous blue grass of the more northerly States of America. In India it is particularly abundant on roadsides and delights in an admixture of sand, gravel and ordinary soil, and is one of the first grasses to appear on the partial recovery of *réh* soils. It ascends from the plains to 8,000 feet in altitude, but varies in habit and nutritive qualities according to soil and climate. Is readily propagated by cutting up the shoots and roots and spreading these over the surface of the

Propagation.

prepared soil, or depositing them in furrows, each row of cuttings being covered over by the preparation of the next furrow or by hand dibbling the cuttings all over the field.

Fodder.

It is the commonest and most useful grass in India, since its stems and roots form a large proportion of the food of horses and cows ; it has great fattening and milk-producing qualities. Makes good hay, which if carefully stacked will keep for years. Voelcker (*Improv. Ind. Agri.*, 175) says of *dúb* grass in India that " in

Cultivation.

many parts it comes up naturally or may be easily propagated from cuttings simply stuck in the ground. As a crop for irrigation it gives a great yield, and is about the only grass that keeps green in the hot weather. To one coming newly to the country it is surprising to notice how from an apparently burnt-up and dead surface a crop of fresh grass will spring up on the first fall of rain." According to the *Madras Experimental Farm Manual*, *dúb*, like most other meadow grasses, should be cut for hay directly the flowers appear, since under these circum-

Crop.

stances the juices are more nutritious and the plant will produce another crop much sooner. The great object should be to retain the green colour of the grass by drying it as quickly as possible ; two or at the most three days should suffice for making the hay, and if the dews are heavy it should be put into haycocks at night. The richness of the saccharine juices renders the hay more liable to heat and ferment, but excess in this direction may easily be checked by the ordinary methods of putting pipes from the centre to the outside of the stack, or building in two or three layers of dry *paddy* or *cholam* straw.

It is necessary, however, to notice that **C. Dactylon**, while very easy to grow, is very difficult to eradicate. In the *Farm Rept. Bombay* (1898–9, 6) it is said to be a persistent weed in black soil and to require deep hand-digging in the hot

Medicine.

weather to destroy it. The plant is used medicinally and a cooling drink is said to be prepared from the roots. *Dúb* is also used fairly extensively in Hindu religious ceremonies, but it is necessary to distinguish carefully *dúb, dáb, dab* and *dib*, which denote separate grasses.

D.E.P., ii., 682–9.
Sedges.

CYPERUS, *Linn.* ; *Fl. Br. Ind.*, vi., 591–619 ; Prain, *Beng. Plants*, ii., 1138–45 ; CYPERACEÆ.

This genus of sedges contains some 60 Indian species. Most of these are fairly valuable fodder plants, especially when young, others are dangerous weeds of cultivated lands. A few yield culms and leaves that are employed in thatching and in grass-matting, and others afford tuberous rhizomes that are either eaten (especially in times of scarcity) or are collected and sold as perfumes or medicines. The greatest possible obscurity still prevails, however, as to the determination of the Indian economic species, so that it may for the purposes of the present

Two Economic Groups.

work suffice to discuss them under two groups, those of value because of their tuberous roots and those with culms and leaves utilised in mat-making.

(*A*) *Tuberous Rooted Forms* :—

D.E.P., ii., 683–5.

1. **C. bulbosus,** *Vahl.* ; *Fl. Br. Ind.*, vi., 611 ; *C. jemenicus, Retz.* ; *C. jemenicus, Linn.*, in Roxb., *Fl. Ind.*, i., 192 ; Clarke, *Journ. Linn. Soc.*, xxi., 175, t. 2, ff. 17, 18 (but *var.* β. excl.) ; also *Journ. Bot.*, 1890, xxviii., 18 ; *Fl. Br. Ind.*, vi., 11 ; Trimen, *Journ. Bot.*, n.s., 1884, xxii., 358–61 ; Woodrow, *Fl. W. Ind.* in *Journ. Bomb. Nat. Hist. Soc.*, xiii., 431 ; Gammie, *Rec. Bot. Surv. Ind.*, 1902, ii., 193. The ***shilandi, shilandi-arisi***, *bud, theg, puri-gaddi* (the grass) and *puri-dumpa* (the bulbils).

Sandy Situations.

This small sedge is often very plentiful in sandy situations, as for example in Sind and Baluchistan, the Upper Gangetic basin, the Deccan, Malabar, the Coromandel Coast and Ceylon. It is distributed to Arabia, Abyssinia, Central and North Africa. The characteristic (economic) feature of the plant is the tuberous rhizomes (often called bulbils) that it produces. These are not much larger than grains of rice, and since they are borne on long, thin, non-persis-

Found Free in the Soil.

tent shoots they are found in great abundance in the soil, free from each other and free from the parent plant. They are accordingly collected by sifting the sandy soil. They are encased in several easily separated scaly coats and, after the removal of those, are roasted and eaten or are soaked in water, washed, pounded into a flour, and baked into bread or cooked into puddings, etc. They have no aromatic property, and are strictly speaking edible not medicinal tubers.

D.E.P., ii., 684.
Earth-almond.

2. **C. esculentus,** *Linn.; Fl. Br. Ind.*, vi., 616; *Journ. Agri.-Hort. Soc. Ind.*, 1897, xi., 575–8. This is the Rush-nut, Earth-almond, Tiger-nut or *chufas* of European, American and African writers. Bretschneider (*Hist. Europ. Bot. Disc. China*, 16), while reviewing Kamel's discoveries (1683), identifies the *maa tchi* or *pee tchi* or Chinese Water-chestnut with the present plant. The name Water-chestnut usually denotes ***Trapa*** (see p. 1080).

Chinese Tuber.

If the determination here suggested should prove correct, the Chinese would have to be accepted as having known the edible sedge from as early a date as can be shown for any other country. But it so closely resembles **C. rotundus** that it is highly probable the reputed discoveries of it in India and elsewhere are in some instances at least due to mistaken determinations. It has, however, been recorded as found in one or two localities in the Panjáb and in the Nilgiri hills, but nowhere common. It thus no doubt exists in India, but until fresh investigations have been made it is perhaps desirable to leave the matter in this position. Repeated efforts have, however, been put forth (so it has been affirmed) to introduce the cultivation of this plant, but with absolute failure everywhere. The present species, therefore, contributes no known portion of the supply of edible **Cyperus** tubers in India. Of other countries it is reported the tubers are often roasted, then ground to a powder, and used in the preparation of *chufas* coffee or *chufas* chocolate. [*Cf. Kew Mus. Guide*, 1895, No. 2, 59.]

D.E.P., ii., 686–7.
Motha.

3. **C. rotundus,** *Linn.; Fl. Br. Ind.*, vi., 614; Hove, *Tours in Gujarat, etc.*, 1787, 25, 45, 112, 120; Dymock, *Mat. Med. W. Ind.*, 1885, 844–5; Buckland and King, *Offic. Corresp. Beng. Govt.*, Apr. 21, 1892; *Pharmacog. Ind.*, iii., 552–3; Dewey, *U.S. Dept. Agri.*, 1894, 1–4; Bretschneider, *Bot. Sin.*, 1895, pt. iii., 126; Woodrow, *Gard. in Ind.*, 1899, 547; also *Fl. W. Ind., l.c.* 431; *Bull. Haarlem Mus. Pl.*, 1903, ii., 1145; Gage, *Rec. Bot. Surv. Ind.*, iii., 112; also Prain, *l.c.* 303; Hosie, *Rept. Ssu'ch'uan, China*, 1904, 45. This is the *mothá*, *muthá*, *batha-bijir*, *tandi sura*, *mustá*, *dila*, *gundra*, *korai*, *koreki-jhar*, *bimbal*, etc. Bretschneider points out that the Chinese name for the odoriferous tubers of this species (which occurs in Buddhist books), namely *mu ts'ui ta*, comes from the Sanskrit *mustuka*.

Troublesome Weed.

This is a very troublesome weed of fields, gardens and waste lands, plentiful throughout India from the sea-level up to 6,000 feet in altitude. Its occurrence as an enemy of cultivation has been recorded in nearly every tropical country. The underground shoots that bear the economic rhizomes or tubers are persistent and become woody, the plant being in consequence difficult to eradicate. The best results at extermination have been attained by low shade and repeated mowing down of the herbage. But **C. tuberosus**, *Rottb.*, is a plant so closely allied to it that the late Mr. C. B. Clarke informed me it might quite safely be viewed botanically as a variety of **C. rotundus**. Economically the two plants are identical, and are therefore treated here conjointly. One of them is possibly **C. pertenuis** (or *nágar-moth*) of economic writers (Dutt, Dey, Dymock, Liotard, Buck, etc.), which yields an odoriferous medicinal root but is not **C. pertenuis**, *Roxb.*, which by modern botanists is called **C. scariosus**. Dymock speaks of two kinds of *nágar-moth* met with in the Bombay markets, viz. Surat and Kathiawar. Gammie informs me of two kinds—a small tuber common in the Deccan, and a large one that does not extend beyond the heavy-rainfall zone of the Konkan and the Ghats. Clarke, who most kindly perused this article and made useful suggestions, asked the question—Could the medicinal root alluded to by Dymock and others be **Mariscus bulbosus**, *C.B.C.*? **C. scariosus** has not at all events been recorded as found in Western India. Woodrow writes me that it does not occur in Western India as far as he knows. It is thus hardly likely to be the economic plant **C. pertenuis**, *Dymock*.

Nágar-moth.

Two Kinds.

Aromatic Tubers.

Medicine.

The rhizomes of **C. rotundus**—**C. tuberosus**—are very much larger than those of **C. bulbosus**, are highly aromatic, and when mature are so woody that they could hardly be eaten. Ground into a powder, however, they are used medicinally, especially for external applications as *lep*. They have been regarded as diaphoretic, stimulant and astringent. The Scythians are said to have employed them in their special embalming preparation. They are also used in perfumery, particularly in giving a required aroma to certain fabrics and in the preparation of *oud-bati*—the fragrant sticks burned in Hindu houses to disguise offensive smells. They doubtless constitute much of the so-called *juncus* or *radix junci* and *kuperos* of the Latin and Greek authors, and which was extolled by mediæval herbalists, being sometimes, but erroneously, called Indian *jatamansi.* [See **Cymbopogon Jwarancusa**, p. 462.] It is desirable to bear in mind the hard woody nature and aromatic property of these tubers in order to distinguish them from certain edible tubers to which they bear some resemblance. There would thus seem to be two chief forms of the medicinal and perfumery tubers—the *motha* (***C. rotundus-tuberosus***) and the *nágar-moth* (***C. pertenuis*** of Dymock, *non* Roxburgh).

Eaten. Many writers, however, affirm that the tubers of ***C. rotundus*** and ***C. tuberosus*** are eaten, especially in times of scarcity and famine. They are, certainly, greedily eaten by pigs, and in famine times may therefore be eaten by men. But it would almost seem as if either of two conditions were necessary :—(*a*) that the tubers of certain localities or particular stages of growth are more palatable than the tubers described as medicinal, etc. ; or (*b*) that some altogether different plant affords the edible tubers attributed to this sedge.

Kaseru. Throughout India an edible tuber bears very frequently the vernacular name *kaseru* ; in fact it is mentioned in the *Ain-i-Akbari.* Roxburgh described ***Scirpus Kysoor*** as the *kesur*, common in Bengal and growing on the borders of lakes, ponds, etc. It possesses, he says, tuberous roots, but curiously enough he makes no mention of these tubers being edible. Most Indian writers who mention ***C. rotundus*** as yielding edible roots, speak of the plant, to which they refer, as frequenting the margins of tanks (*Beng. Offic. Corresp., l.c.*). It would thus appear highly probable that the so-called edible tubers of ***C. rotundus*** of many writers may have to be transferred to ***Scirpus Kysoor***, *Roxb.*, which Clarke made a variety of ***S. grossus***, *Linn.* Gammie's *Note on Plants used for Food during Famine, etc., in Bombay,* while it gives ***C. bulbosus***, makes no mention of ***C. rotundus*** nor of ***C. tuberosus*** as having been eaten, but enumerates the following species of ***Scirpus*** as affording edible products :—(*a*) the bulbs of ***S. grossus***, the *kysoor* or *kachara*, and (*b*) the seeds of ***S. maritimus***, the *chid* (the *miraj* of Woodrow). In passing it may be added that so far as can be discovered Gammie's allusion to the "seeds" is the only record of the grain of a Scirpus being eaten. But thinking that Woodrow (formerly Professor of Botany at the Poona College of Science) was likely to be able to throw some light on this question, I asked for his views. His reply was briefly as follows :—"I found tubers in the markets, carried these off to Poona, and produced from them ***S. Kysoor***. The tubers are globular, the size of a marble, have a brown fibrous covering and inward are white, farinaceous with an agreeable flavour." In a similar communication Gammie, the present Professor of Botany at Poona, informs me that the Parsi Vegetable. tubers of ***S. grossus*** are the favourite vegetable of the Parsis during the cold weather. The plant grows abundantly in the fresh-water tanks of the Konkan but not in the Deccan. Lastly, Mr. I. H. Burkill writes me that the Calcutta supply of these edible tubers comes from Patna, Allahabad, Aligarh, etc. In Nowgong the plant is called *ghogal* ; in Ganjam, *santra* ; and in Prome, *myet-thon-myaung.* Burkill then adds that another cyperaceous root is edible. This *Eleocharis.* is believed to be ***Eleocharis***. It is known in the Santal country as *chichoor*, and in Central India (Tonk) it is *kasuria.* There can thus no longer be any doubt that ***S. Kysoor*** is at least one of the edible tubers of India. Hooper (*Rept. Labor. Ind. Mus.*, 1906–7, 11) speaks of *keshur* tubers from Singapore, which it would appear are regularly imported and sold in the Calcutta market.

(*B*) *Fibrous or Mat-making Forms* :—

4. **C. corymbosus**, *Rottb.* : *C. semi-nudus, Roxb., Fl. Ind.*, i., 187 ; *Fl. Br. Ind.*, vi., 612. A glabrous rush-like sedge which often grows to the height of two to three feet. It is met with from Kumaon to Assam and Burma, and is distributed to Ceylon, Africa and America. It is known in India as *gol-methi, mutha, goddu tunga, kodu, kurai, berhua, nwa-myet-yin.* *Var.* β. ***Pangorei***, *C.B.C.*, is founded on a specimen furnished by Dr. Bidie from Tinnevelly, which had been originally obtained from Madagascar. This removes, therefore, any doubt regarding the material of the finer mats of that locality.

D.E.P., ii., 685-6. 5 **C. malaccensis**, *Lam.* : *C. gangeticus* (MS.), *incurvatus, Pangorei* and *procerus, Roxburgh's Fl. Ind.*, i., 203 ; Prain, *Beng. Plants*, ii., 1144 ; *Fl. Br. Ind.*, vi., 608. A native of brackish mudbanks from Bengal to Sind and distributed to Singapore and the Persian Gulf. It is in Bengal known as *chumati pati*, and apparently by popular writers has been much confused with ***C. corymbosus***. Hance (*Journ. Bot.*, 1879, viii., 99–105) gives a most interesting account of the matting sails and floor-mats of China. The former are not exported, but the latter constitute an important item of traffic from Canton to the United States of America. Hance identified the plant as ***C. tegetiformis***, *Roxb.*, but C. B. Clarke informed me that he regarded it as being more correctly ***C. malaccensis***.

6. **C. tegetiformis,** *Roxb.; C. nudus, Roxb., Fl. Ind.*, i., 209; *Fl. Br. Ind.*, vi., 612; Prain, *l.c.* 1144. This form is closely allied to ***C. malaccensis***, and the two plants seem to have often been confused by economic writers. It is a native of Bengal (Central and Eastern—the Sundribans), Chittagong, Assam, Bandelkhand and Madras, and is distributed to China and Japan. A tall glabrous rush-like sedge known as *gola-methi* or *sura*.

D.E.P., ii., 688.

7. **C. tegetum**, *Roxb.; Fl. Br. Ind.*, vi., 613; Prain, *l.c.* 1144; the Sedge or Grass-matting Plant of Calcutta, the *mudar-kati, wetla, korai, mandri, yerkuti*, etc. An extremely abundant and widespread sedge. It occurs throughout the plains and ascends the hills to 6,000 feet in altitude from Kashmir to Burma.

D.E.P., ii., 688–9.

GRASS-MATS: Calcutta-mats: Madras-mats.—Here and there throughout the greater part of India mats are made of the culms of certain species of sedge. Some are coarse, being woven of the entire culms, and others exceedingly fine, the triangular culms being split into two, four, eight, twelve, etc., pieces. These strips of culms are carefully dried, when it is found they have rolled round on themselves lengthwise, thus carrying the polished epidermis uniformly on the outside of the rush-like strands. The process of splitting the culms is perhaps the most difficult and laborious part of the grass-matting art, especially when exceptionally fine mats are to be woven. The collection of the culms and the splitting and drying of the same are duties entrusted to the women, whose patience and delicate fingers are in consequence important factors in success. The men do the weaving. The species of sedge most largely used is ***C. tegetum*** (No. 7 above), but Nos. 4, 5, and 6 are (according to some writers) each and all employed in the localities where procurable abundantly. In fact, as already stated, the finest mats are those produced in Tinnevelly from ***C. corymbosus**, var. **Pangorei***. But the question whether the production of the finer mats necessarily depends on the special properties of the sedge used or on the patience and skill of the operators has never been definitely investigated. In certain regions species of sedge are used in the mat trade that in other countries are never so employed, though plentiful. The greatest uncertainty still pervades the literature of the grass-mat trade, more especially as to the particular forms of sedge used in the centres of special repute. But the exceedingly fine mats of Tinnevelly, Cochin, Pallampett, Palghat, Vellore, Indrawatty, Sevry, Talpier, Midnapur, etc. Mats, though often marvellously fine, very beautiful and highly artistic, are commercially much less valuable than the ordinary grass-mats, the so called Calcutta-mats or *mudár*-mats, which are made mainly, if not exclusively, of ***C. tegetum***.

Calcutta-mats.

Splitting the Culms.

Tinnevelly Mats.

Palghat and Midnapur Mats.

Manufacture.—The method pursued in the fabrication of grass-mats, however coarse or fine, is the same with all the Indian grass-mats, and may be here briefly detailed. Threads of ordinary country twine (more rarely cotton) are stretched along the surface of the floor of the factory or workshop, one inch or an inch and a half apart, and extending for the length of the desired mat. If intended for a large-sized room they may cover, or nearly so, the entire floor of the workshop, or may be placed in one corner, being only a few feet in length and breadth, or many yards in length and only a few feet in breadth (the last being a

Manufacture.

sort of piece-goods form which has recently been sent to Europe and America very largely). The lengthwise strings constitute the warp of the mat. Previously they have been threaded through a crudely formed weaver's comb or beam of the desired breadth, and they have also been attached to bamboos at both ends, which are so adjusted that they may be tightened as desired and the warp raised an inch or so above the floor of the room over which they are stretched. The operators commence at the far end. They sit in a row across the breadth of the fabric and on the top of it. Each possesses a crudely formed wooden needle (which takes the place of the shuttle), and through the eye of this is inserted the end of the split and carefully prepared culm. This is passed alternately over and under the threads of the warp and thus placed in position by each operator along his allotted portion of the weft. Simultaneously the comb is beaten home and the next street of the weft commenced by being threaded above the warp, where the previous street went below. If colours or patterns are desired they are inserted by the hand at the proper positions. Thus slowly the work progresses. It is hand labour from beginning to end, for so far machinery has not invaded this peculiarly tropical craft, the prototype very possibly of the weaver's art.

Warp.

Weft.

Madras Mats.

As already indicated, the finer artistic and coloured mats are mainly derived from Madras; the plain white mats, or mats with coloured borders only, come from Calcutta. In Western India grass-mats are never made, though several of the plants required appear to be fairly plentiful. The mats of Bombay are made from the leaves of ***Phœnix robusta**, Hook, f.*

Statistics of the trade in grass-mats cannot unfortunately be given. It is known that large quantities are regularly exported, and within recent years the trade has greatly expanded. But the grass-mats are returned conjointly with all other **Mats and Matting Materials** (see p. 776).

D

D.E.P., v., 168 9; vi., pt. i., 427.

Dairy Farming.

Stock.

Produce.

DAIRY FARMING AND DAIRY PRODUCE.—In its modern comprehensive signification Dairy Farming embraces not only milk but many other substances, the production of which can be economically combined with the supervision of milch-cows. These may be classified as follows:—*Live-Stock*—such as oxen, buffaloes, sheep, goats, pigs, poultry and bees. *Produce*—meat, milk, *dahi*, butter, *ghi*, cheese, fowls, ducks, eggs, honey, bees'-wax, hides, skins, wool, horns, hair, feathers, bristles and farmyard manure. *Requirements*—capital and stock, technical knowledge, suitable buildings, grass lands, a supply of cattle food and fodder, appliances and machinery, and easy, quick and cheap transport to large markets.

So far as known, no one in India has as yet attempted Dairy Farming in anything approaching the degree of thoroughness necessary to ensure complete success. While that is so, the larger towns have recently begun to receive some portion of their supplies from establishments usually designated Dairy Farms, and for same years past the necessity for a large and pure supply of milk and butter for the British troops resident in India has induced the military authorities to organise special dairy farms of their own. In Thacker's *Directory* (1905, 28-30) mention is made of the following Dairies:—Bengal, 4; United Provinces, 11; Central India and Rajputana, 2; Panjáb, 6; Assam, 1; Burma, 1; Bombay, 18; and Madras, 5. Still, the problem of the protection of the public against disease through the supply of impure and adulterated milk has hardly been even contemplated. For kindred subjects consult:—**Bees and Honey** (see pp. 123–9); **Poultry and Ducks,** etc. (pp. 134–6); **Feathers** (pp. 138–42); **Eggs** (p. 137); **Hides and Skins** (pp. 632–40); **Horns** (pp. 644–6); **Manure, Farmyard** (p. 768); **Pigs and Bristles** (p. 752); and **Wool, Hair and Pashm** (pp. 1121–31). In the present article Dairy Produce, such as Milk, Butter, Ghi, Cheese, etc., will be dealt with in such detail as space will admit.

Indian Dairies.

Kindred Subjects.

Produce.

History.—Voelcker (*Improv. Ind. Agri.*, 1896, 206–11) has very properly observed that "the two most striking features of Indian dairying are, the small yield of milk given by the cows, and the richness of the milk of the buffalo. In Bengal the ordinary country cow will not give more than 2 lb. of milk a day. In Madras it may yield from 2 to 4 lb. a day. As a rule, the cows will only milk for six months, and often have but one calf in the course of two years. The milk of the buffalo, on the other hand, is very much richer than the average cow's milk in England, for, whereas the latter may be said to contain 3 to 4 per cent. of butter-fat, and 12 to 13 per cent. of total solids, buffalo's milk has no less than 7¾ per cent. of butter-fat and 18 per cent. of total solids." These are exceedingly important facts which cannot be overlooked. No conception of the value and extent of dairy farming in India could be formed were the part played by the buffalo and the goat to be omitted.

Small Yield.

Rich Quality.

Buffalo and Goat.

Another highly significant feature is the extent to which milk and the preparations derived from it are boiled before being eaten. Milk, butter and cheese have been boiled preparations from the most ancient classic times of India—(confer with the references below to the *Institutes of Manu*)—a direct and practical adaptation doubtless to the greater danger in the East than in the West of consuming articles of food so liable to contamination as milk and its derivatives. Buchanan-Hamilton (*Journ. Mysore, etc.*, i., 6, 116; ii., 14–5, 382) wrote in 1807 an account of the milk and butter of Mysore that is fully corroborative of the extent to which in India boiling is and has always been an essential feature. His description is not only true to-day (and not of Mysore only, but of the greater part of India), but it is one of the most concise and accurate that has been penned. It may, therefore, be interesting to give here an extract from that historic work:—"The cattle in this country are milked by men who carry the produce home to the women; for they prepare the butter. The milk on its arrival, is immediately boiled for at least one hour; but two or three hours are reckoned better. The earthen pots, in which this is done, are in general so nasty, that after this operation no part of the produce of the dairy is tolerable to an European; and whatever they use, their own servants must prepare. The Natives never use raw milk, alleging that it has no flavour. The boiled milk, that the family has not used, is allowed to cool in the same vessel; and a little of the former day's *Tyre,* or curdled milk, is added to promote its coagulation, and the acid fermentation. Next morning it has become *Tyre* or coagulated acid milk. From the top of each potful, five or six inches of *Tyre* are taken, and put into an earthen jar, where it is churned by turning round in it a split bamboo." . . . "After half an hour's churning some hot water is added and the operation is repeated for about half an hour more; when the butter forms. The Natives never use butter but prefer what is called *Ghee* not only as that keeps better but also as it has more taste and smell. In order to collect a quantity sufficient for making *Ghee* the butter is often kept for two or three days and in that time a warm climate renders it highly rancid. When a sufficient quantity has been collected it is melted in an earthen pot and boiled until all the water mixed with the butter has been evaporated. It is then taken from the fire. . . . It is eaten when even a year old." Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 277) gives the following:—"*Chhana* or curd is prepared by boiling the milk, and by adding to it while hot, some acid milk, which coagulates the whole into one mass. This is put into a cloth and the whey expressed so that it is a kind of cheese." In his *Gazetteer of Bihar and Patna* (published by Montgomery Martin) Buchanan-Hamilton speaks of two distinct classes of milkmen: the one, he says, churns the milk as it comes from the cow,

Boiled Preparations.

Boiled for at least one Hour.

Curdled Milk (*Tyre*).

One Year Old.

Two Classes of Milkmen.

Typhoid Fever.

Cream.

and the other boils and curdles it before attempting to separate the butter. The former thus produces fresh butter and *mahuya-dahi*, the other boiled milk-butter and *mitha dahi*. To the present day Monghyr and Bhagalpur enjoy the reputation of producing high-class butter from fresh (not curdled) milk. But in India as a whole the manufacture of butter from fresh (not boiled) milk is only occasionally practised, and mostly in response to European demand. The high death-rate of Europeans from typhoid fever may to some extent be a result of their objection to Native boiled milk and boiled butter. The Natives, when they do make fresh butter, never attempt, however, to set the fresh milk aside to allow the cream to rise to the surface, since it would most certainly, under the tropical conditions, sour and be thus ruined. In fact it may be said the Natives of India do not know cream, the substance they skim from *dahi* being rather crudely formed butter than cream. But sometimes the boiling of milk is continued until it is reduced to a kind of extract called *khyir*—a substance largely employed by the sweetmeat makers. The milk of goats, cows and buffaloes, when available, is invariably mixed before being treated in the manner above indicated.

I have given these passages from one of the most observant of Europeans who ever resided in India, not only because they are fully expressive of modern Indian practice but because they were penned long before the discoveries that in Europe have revolutionised dairy practice and knowledge and recently begun to modify Indian methods. Thus then it may very nearly be said that the milk, butter, cheese, etc., of India are all cooked, if they might not be called sterilised, articles of food.

[*Cf. Institutes of Manu* (Milk), v., 8; viii., 231, 326; xi., 133; xii., 62: (Curdled Milk, *Dahi*) v., 10; xii., 63, etc., etc.; *Ain-i-Akbari*, 1590 (Milk, Curds, *Ghi*), i., 63; Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 17, 29, etc.; Moorcroft, *Trav. Himal.*, 1841 (Milch-kine and Milk), i., 58–9; ii., 40; Masson, *Journ. Kalat*, 1843, 435–6; Vigne, *Trav. Kashmir*, 1842 (Milk), i., 300; Ainslie, *Mat. Med.*, i., 219–26; *Taleef Shereef* (Playfair, transl.), 1833, (*Peoke*), 54 (*Dhaie*), 83; Montgomery Martin, *Trav. E. Ind.*, 1838, i., 120–1, 341, 371, app. 31, 41, 53; ii., 255, 422, 567, 942–3; iii., 317, 492, app., 703, 710; O'Shaughnessy, *Beng. Disp.*, 1841, 690; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880 (*Dudh-wala*), 104; *Mad. Exp. Farm Rept.*, 1883 (Cheese Making); Wallace, *India in* 1887; Sen, *Rept. Agri. Stat. Dacca*, 1889, 54–7; Basu, *Agri. Lohardaga*, 1890, 44; Banerjei, *Agri. Cuttack*, 1893, 128–30; Lawrence, *Valley of Kashmir*, 1895, 359, 392; Bhagvat Sinhjee, *Hist Aryan. Med. Sc.*, 1896, 130; Wallace, *Ind. Dairying*, in *Blackwood Mag.*, 1898; *Sterilised Ind. Milk*, in *Ind. Agri.*, Oct. 1898; Watt, *The Indian Churn*, *Agri Ledg.*, 1895, No. 23; *Rept. Ind. Hemp Drugs Comm.*, iii., 94, 145 (*Ghi* in electuaries); *Ann. Rept. Allahabad Dairy Farm*, 1893–1903; *Exp. Farm and Garden Repts. Bomb.*, 1902–4; *Imp. Gaz.*, 1905, iii., 1-95; Watt, *Inaugural Address School of Pharmacy*, in *Pharm. Journ.*, Oct. 6, 1906.

[An instructive and valuable series of papers on Dairy Produce will be found in the *Journals, Handbooks and Bulletins U.S. Dept. Agri.*; *Journ. Engl. Board of Trade*; *Colon. Agri. Dept. Repts and Soc. Journ.* and other special European, Colonial and American publications, etc., etc. The chief writers, in order of date, are W. H. Conn, C. C. Georgeson, R. A. Person, S. M. Tracy, H. E. Alvord, F. T. Bond, A. C. Macdonald, F. J. Lloyd, T. E. Thorpe, A. E. Leach, etc., etc.]

D.E.P., iii., 4-5. Milk.

Castes of Dairymen.

Sanskrit Knowledge.

1. ***MILK AND CREAM. Composition and Properties.***—It may be explained that in Upper India there are two main castes who are dairymen. These are the *ghosís* and the *gwállas*. The former have no other occupation, and sell their milk and *dahi* (*khoya*) to the *halwaís*. The latter are cultivators as well as milkmen, but they rarely sell their produce to the *halwaís* but to the actual consumer direct. Dutt (*Mat. Med. Hind.*, 1900, 281–3) gives many interesting particulars regarding the properties attributed by the Hindus to the various kinds of milk and the preparations from it. He discusses cow's milk, buffalo's milk, goat's milk, ewe's milk, mare's milk, ass's milk, camel's milk and human milk. He then mentions the following preparations, of which he gives the Sanskrit and sometimes the vernacular names:—butter-milk (*takra*), curdled-milk (*dadhi* or *dahi*), whey (*mastu*), curd (*kilataka*, vern. *chhená*), cream (*santaniká*), butter (*navanita*), and clarified butter (*ghrita*, vern. *ghi*).

After the buffalo and the cow, the goat is the most important milk-giving animal, but its milk is poor in butter-fat and thus not of much value in the manufacture of *ghi*. The sheep, while not much employed in the supply of milk, is so used in some districts of the Panjáb, as for example Montgomery and in many parts of Rajputana, and the butter is made into *ghi* which fetches the same price as cow's butter. It is said that in Rajputana a flock of 100 sheep can be maintained at the same cost as ten buffaloes and yet the yield of milk and butter is nearly treble. Sheep.

A fair amount of information has been published in recent years on the composition of Indian as compared with European milk. Leather (*Agri. Ledg.*, 1900, No. 19, 195) says " the composition of cow's milk has been found in England to be very regular for different breeds, and to possess a relationship between the several component parts of all breeds. It is of importance to know whether these relationships hold good for Indian breeds of cows and to what extent they vary in the case of the buffalo." Indian *versus* European Milk.

" It has been found in England that (*a*) there exists a relationship between the solids-not fat, the fat and the specific gravity, and (*b*) between the proportions of proteids, lactose and mineral matter (ash), and that these relationships are constant, within certain limits, for all the several breeds." The proportions of proteids, lactose and mineral matter were found to be as 9 : 13 : 2 in English, and the same with Indian milk. " In the case of the buffalo milk, however, the relationship is different, that of the proteids being distinctly higher and that of lactose lower, than in cow's milk." Leather gives numerous tables showing the analyses of cow's and buffalo's milk (and these should be consulted); he then concludes by observing that generally it may be said :— Cow *versus* Buffalo.

(*a*) The milk of the Indian cow contains a high proportion of butter-fat, varying from 4 up to 6 per cent. Buffalo's milk contains usually much more, varying from 5 or 6 per cent. up to as much as 10 per cent ; Relative Composition.

(*b*) The percentage of proteids (albumen and casein) usually varies in cow's milk from 3·1 up to 3·5 ; in buffalo's milk from 3·5 up to 4·3 ;

(*c*) The percentage of milk sugar (lactose) in the cow's milk varies from 4·4 to 5·0, and in buffalo's it is present in about the same proportion ;

(*d*) The percentage of mineral matter in cow's and buffalo's milk varies from about 0·7 to 0·8, as it does in the English cow's milk.

Mollison (*Agri. Ledg.*, 1895, No. 5, 53) observes :—The quantity and quality of the milk varies greatly by the nature of the food given. " The morning's milk is usually not so concentrated as the evening's milk, but on the other hand the morning yield is greater." But so constant is the composition and sp. gr. of milk that extreme variation from the standard must be accepted as denoting adulteration. The milk-sugar present in Indian milk to the extent of from 4·6 to 5·05 exists in a state of solution, and hence it very easily undergoes decomposition and is in consequence converted into lactic acid and the milk is then spoken of as sour. This fermentation at once becomes active when milk rises in temperature above 15° C. (59° F.). To ensure the preservation of milk it must therefore either be cooled below that temperature or retained at 50° C. The curdling of milk is the result of lactic fermentation, but this may be accomplished by means of organic or mineral acids or is simulated in cheese-making by the precipitation of casein by means of rennet. But rennet (the digestive agent of the stomach of a calf) has induced other changes than the mere precipitation of the casein, and its action is far greater than Quality in Relation to Food. Sp. Gr. Milk-sugar. Milk-preservation. Curdling.

Sour Milk *versus* Curds.

that of lactic fermentation. This is the difference between sour milk and curds. But milk and cream are soured by a large number of different forms of bacteria which are communicated by the udders of the cow, the hands of the milkers, the vessels into which milked, or simply through permeating the atmosphere of the byre and the store-house. In many ways, therefore, they may be conveyed to and absorbed by the milk when kept in open vessels. The reader will find many highly important suggestions on this subject in an article recently contributed by C. Bergtheil (*Agri. Journ. Ind.*, i., pt. iii., 233). "Milk and Cream," he observes, "are naturally ideal media for the development of organisms, so much so that a sample of cream ripe for butter-making has been found to contain as many as 1,500,000,000 bacteria per cubic centimetre, far more than those found in sewage or any other natural material which has been examined. It, therefore, becomes a matter of great industrial importance to preserve milk from harmful fermentations, particularly those occasioned by pathogenic organisms."

Sterilising.

Tainted Milk.

Fermentation Germs killed.

Sterilised Milk.—The greatest cleanliness is imperatively necessary, for even proximity to offensive smells will taint the milk. Some of the fermentative germs immediately start growing and commence the souring process, but these are instantly killed if subjected to a temperature of 50° to 75° C.; and should the milk also contain pathogenic germs (*i.e* the germs of such diseases as typhoid fever) these will at the same time be destroyed. But other fermentative germs are latent and little affected by such temperatures as mentioned. In fact they are only killed either by continued boiling for some hours or by repeated heating and cooling. While left in the cool stage they are induced to assume the active condition, and are then killed by the succeeding heating. Repeated heating will thus serve the same purpose and more effectively (though more troublesome) than continued boiling, and it avoids the undesirable changes in flavour caused by prolonged boiling. When once completely deprived of the germs of its fermentation by heat, milk is described as sterilised or "pasteurised." Even if not protected it will now remain wholesome for some considerable time, but if kept in airtight vessels or bottles may be stored for months without undergoing any injurious change. The success of the Agra, Aligarh, Allahabad, Cawnpore, Darjeeling, Jabbalpur, Lucknow, Ootacamund, Poona, etc., dairy farms in supplying sterilised milk is being followed by many other institutions, so that supplies of good and safe milk may be now had in all the larger towns. The trade is a prosperous one with immense possibilities for the future.

May be stored.

Sale of Sterilised Milk.

Modern Traffic.

Preserved Milk (khir).

Preparation of.

Thickened Milk.

PRESERVED OR CONDENSED (DESICCATED) MILK.—This is made by boiling fresh (whole) milk, to which sugar has been added, until it attains the consistence of syrup. This is called *khir* (*khyir*) and in some parts of India *rabbri*, but sugar is not always added. Of Bengal districts, Tippera is spoken of as producing *khir* of special quality. Sen, discussing Dacca, says, "The flavour of this preparation of milk depends on (*a*) the quantity of milk boiled at a time, (*b*) the care with which the milk is stirred at the time of boiling, and (*c*) the nature of the heat applied. (*a*) To obtain *khir* as white as possible, and possessed of the best flavour, not more than half a seer of milk should be boiled at a time. (*b*) All the time the milk is boiling it should be stirred with a wooden rod. Some prefer to stir with a number of rods. (*c*) A strong and steady heat should be applied. Tamarind wood is considered the best fuel for this purpose. *Khir* of an inferior quality is sometimes made from fresh butter-milk." Banerjei remarks, "In order to get the *khir* or thickened milk of a fine white colour, a little flour is added. In private houses arrowroot is used instead. When thick enough it is removed and allowed to cool, when it is ready for sale."

Condensed Milk.

Action of. Sugar.

This is, therefore, a different substance from desiccated or strained *dahi*, although both are largely used by the sweetmeat makers. It has been recently upheld that the *khir* or *khowa* (*mawa*) made from separated milk is as good and marketable an article as that from whole milk, and hence the double profit in the *khir* and the butter. It has also often been urged that India might do a large trade in the production of condensed milk and in milk boiled down to a powder. Sweden, with its population of five millions, is believed to produce annually and export £2,000,000 worth of preserved and dried milk, a large share of which comes to India, instead of India itself exporting these preparations of milk. Thorpe and others have pointed out that the action of sugar in desiccated milk is preservative, but for this purpose 12 per cent. of the weight of the milk must be sugar. [*Cf.* Fleischmann, *The Book of the Diary* (Aikman and Wright, transl.), 1896, 282–6; Thorpe, *Dict. Appl. Chem.*, ii., 615.]

Preservative Agents.

Smoked Milk.

Thickening Water.

Reputed Preservative Agents.—In this connection also reference may be made to the passage above where Buchanan-Hamilton remarks that it is very nearly the universal practice to boil the milk immediately it is drawn from the cow, goat, etc. This fact cannot be reiterated too frequently. It will have been observed also that the earthen pots into which the animals are milked are often so nasty, to European taste, as to be regarded as destroying the milk. It may be explained that in many parts of India it is customary to smoke the milking-pots, but whether this is done to directly impart the smoky flavour or from the belief that it has a protective action, does not appear to have been investigated. When milk is to be carried for a distance it is placed in earthen pots with fairly large open mouths. These are swung over the shoulder by means of a bamboo, and a swift runner carries the milk to its destination. Within the mouths of such earthen or brass pots it is customary to find a few twigs or leaves—such as rice straw, date-palm leaves, twigs of ***Cocculus villosus*** or leaves of ***Pedalium Murex***. The milkmen affirm these prevent the milk turning sour, but it is much more likely that their action is mechanical in preventing the milk from lapping over or being churned. ***Cocculus*** and ***Pedalium*** are known to have the curious property of thickening water, and may be added to the milk with the object of preventing the detection of water adulteration. Any one who will take the trouble to go to a railway station in the early morning and witness the arrival of Calcutta's daily supply of milk will not be surprised at the danger of direct and accidental adulteration, but rather at the rarity of outbreaks of disease being attributed to the impurities of milk. Speaking of Bombay experience, Lisboa (*Journ. Bomb. Nat. Hist. Soc.*, 1887, ii., 143) mentions the fact that arrowroot is employed to thicken milk which has been watered. [*Cf. Agri. Ledg.*, 1893, No. 17, 114–5; *Pharm. Journ.*, *l.c.*]

Chemical Agents.

In concluding these observations on the preservation and manipulation of milk it may be added that boracic acid, carbonate of soda, carbonic acid, salicylic acid, oxygen and saltpetre, as also several other substances, are all spoken of as milk-preservatives, because they retard the action of the bacteria.

Separators.

Separators.—Some few years ago (1889), at the suggestion of the Bombay Government, the Dairy Supply Company sent Mr. Howman to India in order to "ascertain by trial whether the cream separator is needed in India, and whether it can be profitably utilised in the manufacture of *ghi*. After an extended tour in several provinces, and after having made various trials, the following conclusions were published:—

Tak.

"1. *Tak*, a bye-product of *ghi*-making, can be prepared perfectly well from separated milk.

Mawa.

"2. *Mawa* or *Khowa*, which consists of desiccated milk sweetened with sugar, can be made from separated milk, and the cream saved for butter or *ghi*.

Ghi.

"3. As much *Ghi* can be made from separated cream as by the Native process." [*Agri. Ledg.*, *l.c.* 111.]

Cream lighter than Milk.

There are many designs or patterns of separators, but the principle is the same in all. They take advantage of the fact that cream or butter-fat is lighter than milk. By centrifugal force the liquid revolving within a

Immediate Separation.

Bombay took the Lead.

European Dairies Organised.

cylinder at once, therefore, separates into cream in the middle and milk on the outside, and these two portions are conveyed away by separate pipes into the vessels placed for their reception. The milk can be separated immediately on its being taken from the cow. It is not required to be exposed in a large number of shallow basins; the milk as drawn from the cow may at once be placed in the separator. By a hand separator from thirty to forty gallons may be disposed of per hour. Obviously such results and advantages were of interest to every one in India, and it is no matter for surprise, therefore, that the new system attained almost immediate popularity. In June 1890 the late Mr. Ozanne, then Commissioner of Settlements and Agriculture, Bombay, obtained permission to employ Mr. Keventer, who had been Mr. Howman's assistant, and to purchase two separators. In a remarkably short time dairies, managed on the European system, sprang into existence here and there all over India. The fact of the double produce, (*a*) butter (*ghi*) and (*b*) milk, from which *mawa* could be manufactured, was sufficient justification. All the larger towns of India are now rapidly being supplied with superior butter, also with sterilised milk and cream, conveyed in sealed cans or bottles. As might have been anticipated, however, the greatest progress has been made in the Bombay Presidency where the experiment originated.

Imports.

Trade in Milk.—Absolutely no information can be given regarding the internal trade in milk. Within the past few years the foreign traffic has been officially recorded. In 1902-3 the imports of condensed milk were 1,490,154 lb., valued at Rs. 4,08,251; the following year, 1903-4, they had suddenly expanded to 4,137,066 lb., valued at Rs.11,34,187; and in 1906-7 became 6,196,492 lb. and Rs. 17,68,347.

[*Cf.* Dutt, *Mat. Med. Hind.*, 1900, 281-3; Leather, *Europ. Dairying Ind.*, *Agri. Ledg.*, 1893, No. 17; 1900, No. 19; Mollison, *Milk and Milk Products*, *l.c.* 1895, No. 5; Fleischmann, *l.c.* 6-159; *Dairy Farms, Bengal Command Admin. Rept.*, 1899-1903; Collis Barry, *Legal Med. Ind.*, 1903, 562; Meagher and Vaughan, *Dairy Farming in Ind.*, 1904, 80-8; *Imp. Gaz.*, *l.c.*; Watt, *Journ. Pharm. Soc. Gt. Brit.*, Oct. 6, 1906.]

D.E.P., iii., 4-5. Dahi.

2. ***DAHI OR CURDLED BOILED MILK.***—The names most generally given to thickened or coagulated or specially soured boiled milk are *dahi*, *dadhi*, *khoyá*, *mává*, *tyre*, etc. It is usually prepared by throwing boiled and partially evaporated milk into a vessel that has contained *dahi*, but has not been subsequently washed. At other times a certain quantity of *dahi* or some other acid substance is added to the boiled milk, or a vegetable or animal rennet is employed. Sen, speaking of Dacca, observes that, "To understand the method of preparation of *dadhi* of superior quality, we should remember that its formation depends on a fermentation of milk, and that milk undergoes a number of other fermentations besides that of *dadhi*, and that the particular fermentation it will undergo depends on the conditions under which this takes place. It is only when the milk is kept at a certain temperature, when a given quantity of *dadhi* of a particular degree of sourness is mixed with it, and when the extraneous germs of which the atmosphere is full are excluded from it, that the *dadhi* fermentation takes place properly." "A preparation of sugar, *batasha* and spices is sometimes added to the milk which is set to undergo the *dadhi* fermentation."

Dahi *versus* Curd.

As a rule Muhammadans only will use animal rennet, and the vegetable rennets such as ***Withania coagulans*** are not very widely known. Hence *dahi* differs from curd, as prepared in Europe, in being practically sour

Kinds of *Dahi*. Whey. Curd. Cream-cheese. *Chhena*. Sweetmeats.

boiled milk, the fermenting agent being added when it is nearly cold. And the milk, being boiled immediately as obtained from the cow, contains all its fat or butter. In this form it is called *sara*, and if kept hot may be accumulated for some days till sufficient has been collected to form it into *dahi*. This, as Banerjei explains, is therefore *basa-dahi*. If butter be removed from the *dahi* by churning, the liquid that remains is butter-milk or *ghol-dahi* (*máthá*, *lassi*). But a top layer of the *dahi* may be simply skimmed off and used in the manufacture of butter. Hence there may be whole-milk *dahi* (*basa-dahi*), skimmed-milk *dahi*, as well as butter-milk (*ghol-dahi*). *Dahi* in the liquid state is largely consumed; hence its whey (*mastu*) contains all the milk-sugar and its curd (*chhena*) may or may not have embedded in it all the butter-fat. Whole-milk *dahi* thus contains too much fat to be made into cheese. It is, in fact, cream-cheese, and some localities such as Bandel near Hughli and Dacca in Eastern Bengal are famous for their cream-cheeses. When curds are intended to be prepared the acid or rennet is added to the hot milk. This is called *dud-chhena*, but *dahi* is often heated and allowed to cool in order to prepare imitation curds known as *dahi-chhena*. The whey (as it may be called) of *dahi* is separated by pressing the curd within a clean cloth, but if it be completely dried the *chhena* crumbles to a powder. All qualities of *dahi* and also of *chhena* are largely used in cookery and with *khir* constitute the chief ingredients of sweetmeats, which may thus be regarded as possessing all the elements of food and are not merely luxuries like the sweetmeats of Europe.

Trade in Dahi.

Internal.

Trade.—The trade in compressed (or partially compressed) *dahi* is very extensive, and within a radius around the chief cities immense quantities are daily conveyed by rail and road from the country to the towns, the curd being wrapped in damp cloths and deposited in open baskets. *Dahi* and *ghi* are therefore the products of greatest value in Indian dairy farming. Although every resident in India will readily admit that the traffic must be enormous, no sort of computation is possible of the total production of either the one or the other product.

Fermentation Agents.

But in conclusion it may be pointed out that the fermentative agents concerned in the coagulation of sour milk (not boiled), of boiled milk (*dahi*), of soured cream and of the various forms of curds (*chhena*), are probably all different and that success in the production of the manufactures named, to a far greater extent than as yet appreciated, depends on the use of the correct agent for each fermentation. [*Cf.* Sen, *l.c. Dacca*, 1889, 54-7; *Banerjei*, *Agri. Cuttack*, 1893, 128–30.]

D.E.P., i., 556. Butter.

Cream.

Early Mention.

3. ***BUTTER.***—Of India it may be said that two kinds of butter are known:—*nani* or the butter of fresh or only scalded milk, and *makhan* or the butter of soured milk (*dahi*). The former is held to be inferior and more difficult to prepare than the latter, but valued because the butter-milk obtained may be sold as *dahi*, and *khir* may even be made from it. Fresh milk is hardly ever set on one side to allow of the rise of the butter, and in consequence cream (*shar*) can hardly be said to be known in India. The article sold as cream (except that obtained by the modern cream separators) would more correctly be described as liquid (boiled) butter mixed with *dahi*. But the so-called Indian cream (as with the cream of Europe) is set aside to mature or ripen (as it is called), and when sufficient has been collected and matured it is churned and made into butter. Terry (chaplain to Sir Thomas Roe) (*Voy. E. Ind.* (ed. Havers), 1665, 359)

observes that "butter is obtained by beating their cream into a substance like *unto* a thick oyl, for in that hot climate they can never make it hard, which though soft is very sweet and good." Fresh cream (that is to say whole milk) yields a smaller quantity and an inferior flavoured butter than matured cream.

Flavour of Butter.

The peculiar flavour of butter is, in fact, very often a question of the method and degree of ripening that has been pursued. Moreover the best butter-makers lay stress on the necessity for the cream being repeatedly stirred during the ripening process.

Time required.

Temperature.

The time required depends on the temperature of the atmosphere. It will be sufficiently ripe in from 12 to 24 hours if the temperature average from 60° to 70° F., according to Fleischmann, but 90° F. according to Meagher and Vaughan; below 60° it will take 48 hours, but cream should never be allowed to fall below 55° F.

Germs necessary.

The study of the exact germs concerned in the production of recognised flavours of butter is by no means complete, but is engaging the attention of experts. In the near future pure cultures for the maturing of cream may be demanded but the subject is at present not understood, and both in Europe and in India empirical rules prevail.

Presence of Milk.

Cream is not pure butter-fat, but is a mixture of that substance floating in milk. The milk sours, the lactic acid precipitates the casein, and thus forms butter-milk. Butter, however, always retains some proportion of the sour curd mechanically

Rancid Butter.

mixed with it, and upon this depends the souring of the butter and its rancid flavour.

Churning.—Butter consists of the consolidated oil globules present in the milk. These are collected together and compacted into butter by various contrivances that may be called churns. As already fully explained, a small proportion only of butter is made in India from the milk as it comes from the cow. There is very little or no cream-butter made by the ordinary Indian milkmen, for the reason that the climate will not allow of the milk being set on one side until the cream rises to the surface. Recently, however, cream separators have been introduced at the larger centres and cream-butter has in consequence to a certain extent come into use.

Boiled Soured-milk Butter.

The bulk of the Indian butter is of a kind practically unknown to Europe, namely boiled soured-milk butter. It has been estimated that Indian milk yields butter at the rate of one pound to every 14 pints of best cow's milk or 9 pints of buffalo's milk; with separators very much smaller quantities will, however, suffice. The amount of butter nowadays made from separated cream is fairly large, and Bombay and Aligarh might be spoken of as the centres of the trade.

Churns.

In *The Agricultural Ledger* (1895, No. 23) I have described the churns most commonly met with in India. The simplest contrivance of all is a wide-mouthed bottle or bamboo joint into which a quantity of milk is placed and shaken in the hand until the butter forms. Methods of preserving milk and of preparing from it special articles of human diet, that would wholly or partially withstand climatic tendencies, must have early become axioms of household economy in India. But in the consequent development of this knowledge it would seem that the introduction within the liquid of a contrivance intended more fully to agitate it, than could be attained by shaking in a bottle, would be a natural and simple one, which might fairly well have suggested itself spontaneously to the most remote and diverse races. The first conception of this would most probably be a beater worked by the hand.

Rotatory Whisk.

Vertical Plunging Action.

The step from that to a rotatory whisk would be a direct and necessary one. But a vertical plunging action might not so readily suggest itself. This is the position in India. The rotatory churn is common, the vertical rare, though both forms exist. Whether or not the Aryans introduced the rotatory churn, the one most generally used throughout India, Names given.

may be left as a question for ethnology to solve. What can be affirmed of the people of India to-day is that the principle of that churn is known and practised all over the country, and among Aryan as well as non-Aryan races. The most frequent name for the churn is *mathani* (from *matha* to stir or churn). It becomes *mahal, mahab, mathan, matka, madhani, mahaindi, matki, mathni, math, máthána, mattu,* etc. But every part of the contrivance has its own special name, and sometimes the complete apparatus takes the name of the agitator, at other times of the vessel in which the milk is churned. The simplest of all rotatory churns is that used by the ladies of the upper classes: it consists of a shallow basin or plate in which the milk is placed and a whisk made to rotate on the surface of the milk by its handle being rubbed between the hands. Vertical churns are usually made of bamboos and are most frequently used by the hill tribes.

Addition of Hot Water.

Adulteration with Water.

Melting-point.

Buffalo Cream.

Arnotto.

The Art of Churning.—Great skill is required in judging when the churning is complete. If stopped too soon much may be lost in the butter-milk; if too long protracted the butter may become greasy. The almost universal Indian practice of adding hot water, during the middle of the churning process, prevailed in some parts of Europe also, but it is now much condemned by scientific writers. [*Cf.* Fleischmann, *l.c.* 188.] After straining to remove the butter-milk the butter is washed once or twice in order to remove the curd and other impurities, as also as much of the butter-milk as possible. The butter is worked up, squeezed and beaten until it attains the desired consistence, and is then ready for the market. Water is, however, one of the chief adulterants of butter. As much as 25 per cent. may be present, though good-quality butter may sometimes contain as much as 10 to 15 per cent. As already observed, the presence of butter-milk impairs the lasting quality of the butter, and by turning sour makes it rancid. The melting-point of butter is a feature of some importance as it affords a means of readily detecting impurities. Indian butter, curiously enough, has a higher melting-point than European, a fact urged in favour of its great suitability to India. The food given to milch-cows also affects the melting-point of the butter. Cotton-seed, pulse meal, pea straw, ground-nut cake, etc., produce firm butter, whilst most other oilcakes soften it or make greasy butter. The cream from buffalo milk can be churned at a higher temperature than that of the cow and yet produce equally firm butter, and hence one advantage claimed for the churning of mixed cow and buffalo milk. If the mixture be thought to show too strongly the pale (bleached) colour of the buffalo or sheep butter, the colouring ingredient used should be added before churning. The best substance for this purpose is the pigment of the seeds of Arnotto (***Bixa Orellana***). Three ounces of the seeds soaked in 8 oz. olive oil, then strained, makes a good staining preparation. One tea-spoonful to 40 lb. buffalo milk will usually suffice.

Trade.

Production.

Trade in Butter.—Very little of any importance can be furnished regarding India's trade in butter. The article is in daily use by the well-to-do of all castes and communities, but, India being an agricultural country, the supply is home-made. As an indication of the progress in modern dairy farming, it may be mentioned that in the *Administration Report on Dairy Farms in the Bengal Command for* 1901–2 it is stated that 101,402 lb. of butter, 1,119,216 of whole milk, and 182,799 lb. of cream were produced and disposed of at the dairy farms of Allahabad, Jabbalpur, Lucknow, Cawnpore and Agra for that year.

Imports.

The returns of foreign transactions give, however, certain particulars of value. The *IMPORTS* of butter were in 1875–6, 76,658 lb., valued at Rs. 65,433; in 1885–6, 184,183 lb., valued at Rs. 1,65,335; in 1895–6, 211,516 lb., valued at Rs. 2,43,439; in 1903–4, 277,112 lb., valued at Rs. 3,16,536; in 1905–6, 782,738 lb., valued at Rs. 3,12,510; and in 1906–7, 244,577 lb., valued at Rs. 2,66,636. To what extent this may be margarine is not at present known. The EXPORTS of Indian butter appear to have only begun to be separately returned in official statistics about the year 1890–1, when 1,118 lb., valued at Rs. 472, were sent to China and the Straits Settlements. In 1895–6 the exports were 152,462 lb., valued at Rs. 94,780; in 1905–6 they were 307,785 lb., valued at Rs. 2,16,614; and in 1906–7, 298,344 lb., valued at Rs. 2,09,292. It would thus appear that the export traffic is steadily improving. It goes almost exclusively from Bombay, and the countries that take the greater proportion of the Indian butter are Ceylon and Aden, and after these British East Africa, followed by the United Kingdom. This improved export trade is apparently the direct result of the recent endeavour to establish dairy farming on modern lines.

[*Cf.* Ovington, *Voy. to Suratt*, 1689, 324; Terry, *Voy. E. Ind.* (ed. 1777), 133, 198; *Paulus Ægineta* (Adams, transl.), 1847, iii., 74–6; Sen, *l.c.* 56–7; Banerjei, *l.c.* 129–30; Mollison, *l.c.* 59–63; Fleischmann, *l.c.* 106–99; Meagher and Vaughan, *l.c.* 93–108; *Imp. Gaz., l.c.*]

D.E.P., iii., 491–8. Ghi.

Definite Degree of Heating.

Under-cooking.

Decanting.

4. ***GHI (GHEE) OR CLARIFIED BUTTER.*** —***Manipulation.***—It may be said that the three great products of milk in India are *khir, dahi* and *ghi*. The first two have already been disposed of. It is perhaps hardly necessary to describe the preparation of *ghi* (*neyi*) in great detail, since so much has already been said that has a direct bearing on the subject. *Ghi* is clarified butter. That is to say the butter is heated for about twelve hours or until the greater part of its moisture is evaporated. An oil is at the same time formed that rises to the surface, and the refuse (mostly casein) forms below as a sediment. Too much heating is said, however, to cause the *ghi* to assume an acid taste, while imperfect heating renders it liable to putrefaction. Great skill is thus required, but the *ghi* sold in the market has usually been undercooked owing to the loss in weight which takes place when fully cooked. Butter loses about 25 per cent. in the process of clarification. The yield of *ghi* from the butter of the buffalo is higher than from that of the cow. The boiling butter is allowed to be partially cooled, when the *ghi* may be decanted from the top of the sediment. The ordinary *ghi* of the bazárs is principally derived from buffalo milk. One quart of buffalo milk yields about 3 oz. of *ghi*, while the same quantity of cow milk may only afford about half that quantity, or with extra fine qualities, three-quarters of the *ghi* mentioned. *Ghi* from goat milk is very inferior owing to the disagreeable odour it possesses, while that of sheep milk is often spoken of as superior even to buffalo butter.

Old Ghi.

Classic Times.

Old and New Ghi.—So much has been written on the subject of clarified butter or *ghi* that a special volume might have to be written before even the more important historic and trade facts had been exemplified satisfactorily. *Ghi* is mentioned in some of the most ancient of the classic works of the Hindus. It is the *ghrita* of Sanskrit authors, and according to ancient medical opinion the *ghi* of cow milk is superior to that of buffalo or goat. As manifesting the antiquity of the knowledge in this article, it may be mentioned that in the *Periplus* (80 A.D., McCrindle, transl., 12, 113) *ghi* is spoken of as exported from India. It may thus be said to have been closely associated with the life and social customs of the Aryan races, but curiously enough has never been of much value with the people of Mongolian blood. Here and there all over India, especially along its mountainous frontier, certain races, such as the Kashmiris, are said not to eat *ghi* (Lawrence, *Valley of Kashmir*, 339). In the *Ain-i-Akbari* (Blochmann, transl.), 130) mention is made of the allowance to the State elephants. [*Cf.* also Jahangir, *Memoirs* (Price, transl.), 63, 71, etc.]

Preservation.
Medicinal *Ghi.*
100 Years Old.
400 Years Old.
Roghan.

If carefully enclosed in skins while still hot it may be preserved for many years without requiring the aid of salt or other preservatives. It is somewhat significant, in fact, that medical writers should speak of *purana ghrita* (old *ghi*) as being superior to fresh. Dutt, for example, observes that *ghi* ten years old has a strong pungent taste and is of the colour of lac. " The longer this butter is kept the more efficacious it is said to prove as an external application. Clarified butter a hundred years old is often heard of. The richer Natives always have a stock of old *ghrita* of this description which they preserve with care for their own use as well as for distribution to their poorer neighbours." Fryer (*New Acc. E. Ind. and Pers.*, 1672–81, 137), in his description of Surat and a journey into the Deccan, speaks of " the granaries hewed out of stone " and of " several *Tanks* filled with butter of 400 years standing, prized by the *Gentiles* as high as Gold, prevalent in Old Aches and Sore Eyes, one of which was opened for my sake, and a present made me of its black stinking and viscous Balsom." Butter preserved in skins has been known to remain for many years without deteriorating very materially. It usually, however, dries and becomes almost like wax instead of changing colour and assuming the condition of the *purana ghrita* or medicinal *ghi* of the Hindus and the *roghan* of Persian travellers.

Food.
Cookery.
Sweet Oils.

Food.—*Ghi* has been for many centuries at least an important article of food in India. Linschoten and most of the early travellers allude to its extensive employment in all forms of cookery. It is, in fact, used for all purposes to which butter is put in Europe—such as the cooking of meat, fish, vegetables, curries, rice, etc., or utilised in the preparation of sweatmeats, and is also eaten uncooked with bread and rice. With the poor it is a luxury for feast days, and in everyday life its place is taken by sweet vegetable oils.

Adulteration.
Oils.
Starches.
Purification.
Legislation.

Adulteration.—The chief articles used in the adulteration of *ghi* are vegetable oils such as cocoa-nut, ground-nut, cotton, safflower, poppy, sesamum, niger and *kokam*. These are all harmless enough, though cheaper than *ghi*; but injurious oils are also used, especially *mahua*, *Salvadora* (*kakhan*) and castor-oil. Other animal fats, especially mutton, are largely utilised. Starches, such as rice, *bájra*, plantains, potatoes and yams, are frequently resorted to in order to thicken oily compositions. Impure or adulterated *ghi* is also often remade with milk or curd, to render detection difficult. The simplest method of ascertaining adulteration, and to purify the *ghi* at the same time, is to boil a given quantity, and when it is in a state of complete ebullition to dash cold water on it. The oil will rise to the surface and part from its admixtures. One of the most valuable papers on the adulteration of *ghi* is that written by Mr. Shroff, who states that the Bombay *ghi* trade is in the hands of a dozen merchants, and that adulteration is effected, not by the dairymen, but by the traders. The fats used are often most offensive and deleterious substances, at times even obtained from the carcases of diseased animals. Numerous complaints have been made and even legal proceedings recently taken regarding the adulteration of *ghi*. In consequence the necessity for protecting the poor and helpless has been urged as justifying special legislation.

Packing.

Packing.—Formerly all *ghi* was packed in earthen jars (*matkas*), or for transport to a distance in leathern cases (*kuppas*), but in recent years old kerosene-oil tins or specially made tins have been employed.

Production.

Consumption.

Production and Consumption.—The chief *ghi*-producing tracts are the United Provinces, Bengal, Rajputana, Central India, and the Panjáb. It has been estimated that about one-fourth of the total population of India use 8 lb. per head per annum. Assuming these figures to be correct, this would represent a consumption of about 300,000 tons a year, or at a valuation of £45 a ton, say 13½ million pounds sterling. There are no data by which to verify these estimates, but as they stand they are suggestive of India's necessities in this direction.

Trade.

Prices.

Enhancement.

Wholesale Rates.

Trade in Ghi. - ***Prices.***—No doubt by far the greater proportion of the *ghi* produced in India is consumed locally, and never appears either in the trade returns of internal nor of external traffic. It has been ascertained that the retail price of superior *ghi* ranges from 5*d.* to 1*s.* a pound. In the statement of *Prices and Wages* published annually by the Government of India, particulars are given of the prices of *ghi* in certain localities of Western India since 1855. These would seem to show *ghi* selling at a lower price than the figures just mentioned, but the difference between pure first class and adulterated lower grade *ghi* is such as to render averages misleading. Still, the official returns as they stand manifest a considerable enhancement of price. Thus the average for all the Bombay centres in the quinquennial period of 1855–60 was 19·19 rupees per maund, and in 1903, Rs. 35·32; in Sind, Rs. 17·12, and in 1903, Rs. 33·28; in Central India and Rajputana, Rs. 24·3, and in 1903, Rs. 28·38. But taking the quinquennial average of 1871–5 as 100, Bombay is now 112; Sind 124; and Rajputana and Central India 110. In a further series of tables, *Prices and Wages* gives returns of the wholesale rates of *ghi*. These, for the year 1903 (and reduced for purpose of comparison to rupees and decimals of rupees per maund), would be as follows (in sequence of price):—Bengal, Rs. 34·3; Mysore, Rs. 34·1; Sind, Rs. 32·3; Madras, Rs. 31·4; Panjáb, Rs. 30·6: Berar, Rs. 30·4; United Provinces, Rs. 29·9; Central Provinces, Rs. 28·8; and Rajputana, Rs. 27·8. In a still further series of tables the prices of *ghi* are shown for selected centres such as Calcutta, Benares, Allahabad, Lucknow, Bareli, Cawnpore, Meerut, Agra, Ambala. Lahore, Rawalpindi, Multan and Peshawar during the years 1875-6 to 1902-3. These are divided into buffalo *ghi*, cow *ghi*, and each of these again subdivided into 1st sort and 2nd sort. But the provincial averages just given approximate very closely (as the mean between all four classes in each centre), so that it is not necessary to furnish other estimates.

Internal Transactions.

Centres of Supply.

Expansions and Contractions.

Internal Trade.—The total internal trade in *ghi*, as manifested by the railway returns, shows certain interesting peculiarities. The chief EXPORTING provinces are the United Provinces, Rajputana and Central India, the Central Provinces, Madras and Bombay (enumerated in order of importance). But it is significant that the exports of the United Provinces and of the Central Provinces have manifested extreme fluctuations for some years past. Thus from the United Provinces the exports in 1899–1900 were 236,718 cwt.; in 1902–3, 161,670 cwt.; in 1903–4, 140,617 cwt.; and in 1906-7, 164,222 cwt. The exports of the Central Provinces manifest a decline; thus in 1899–1900 they were 86,187 cwt.; in 1903–4, 63,079 cwt.; and in 1906–7, 42,665 cwt. So also the exports of

Rajputana and Central India have shown corresponding fluctuations. In 1899–1900 they were 63,736 cwt.; in 1902–3, 151,451 cwt.; in 1903–4, 130,296 cwt.; and in 1906–7, 83,035 cwt. An expanding proportion of these Central India and Rajputana exports are consigned to the United Provinces, thus making up apparently the deficiencies of these provinces. A large percentage of the total exports are, however, consigned mainly to the port town of Calcutta, followed by Bombay, and appear again in the foreign exports from these towns.

Provincial Peculiarities: Assam. Bengal. Panjáb. Sind. C. Prov. Bombay. Madras. Rajputana and C. India. Mysore.

Turning now to further provincial details, mainly IMPORTS: Assam, with its great herds of buffaloes, exports no *ghi* but draws upon Calcutta and the Province of Bengal for about 9,000 to 31,000 cwt. Bengal Province drains its foreign supply chiefly from the town of Calcutta. The United Provinces, as already said, import largely from Rajputana and Central India. The Panjáb annually exchanges about the same amount, namely from 11,000 to 34,000 cwt. Sind buys largely from Central India and Rajputana and Bombay, a quantity varying from 29,000 to 50,000 cwt. The Central Provinces are self-supporting, since they practically import little *ghi* but export a large amount. The traffic to and from Bombay Presidency is subject to extreme fluctuations. The imports in 1900–1 were 121,257 cwt.; in 1903–4, 10,376 cwt.; and in 1906–7, 10,348 cwt. The exports, on the other hand, were in 1900–1, 16,134 cwt.; in 1903–4, 54,157 cwt.; and in 1906–7, 97,166 cwt. Bihar takes little or no part in the traffic in *ghi*, but its imports are double those of its exports. Madras Presidency is self-supporting, since it imports very little, but exports very largely to its own ports and to Mysore and Bengal. It has already been observed that Rajputana and Central India export very largely, chiefly to the United Provinces, Sind, Bombay and the Panjáb, in the order named, but in years of famine or scarcity these States also import. Lastly, it is significant that Mysore with its herds of fine cattle exports no *ghi* to speak of, but is a fairly large receiving centre, the imports averaging about 14,000 cwt. derived from Coimbatore district in Madras.

The most noticeable feature of the Coasting Trade is the traffic, chiefly from Bengal (followed by Madras), to Burma, which in 1905–6 was valued at Rs. 17,01,609. [See **Sesamum,** p. 986.]

Trans-frontier.

Trans-frontier Trade.—A fairly large quantity of *ghi* is brought across the land frontiers of India. The imports and exports by these routes during the years 1902–7 were as follows :—

——		1902–3.	1903–4.	1904–5.	1905–6.	1906–7.
IMPORTS ..	Cwt.	130,638	164,262	165,463	168,264	185,752
	Rs.	53,08,589	64,05,129	71,93,973	75,86,410	90,73,421
EXPORTS ..	Cwt.	1,588	2,135	3,007	2,342	2,749
	Rs.	90,043	1,20,582	1,49,448	1,37,773	1,61,916

Kashmir. Dir, Swat and Bajaur.

The import traffic is thus exceedingly valuable, and Kashmir stands unmistakably first. Lawrence observes, "It is by far the most important article of the export trade of Kashmir." The supply of *ghi* sent to India from that State was in 1906–7, 74,096 cwt., valued at Rs. 36,23,577. This may fairly be called a prosperous trade, since the figures just mentioned are nearly four times those of twenty years previously. Then come Dir, Swat and Bajaur, which furnished India with 50,544 cwt., valued at

Nepal.

Rs. 23,57,459; and lastly Nepal sent 42,765 cwt., valued at Rs. 22,09,334. The Kashmir *ghi* goes to the N.W. Frontier Province and the Panjáb; the Dir, Swat and Bajaur also into the N.W. Frontier Province; and the Nepal into the United Provinces and Bengal.

The re-exports of foreign *ghi* are unimportant, but have ranged from a valuation of Rs. 1,037 up to Rs. 2,07,185.

Foreign.

Imports.

Consigned to Sind and Bombay.

Foreign Trade.—The IMPORTS being the least important may be disposed of first. This traffic is subject to extreme and sudden fluctuations. In 1876 the imports of *ghi* were valued at Rs. 2,76,395; in 1880–1, Rs. 16,486; in 1886–7, Rs. 7,03,432; in 1890–1, Rs. 4,13,299; in 1896–7, Rs. 4,28,432; in 1900–1, Rs. 10,71,024; in 1901–2, Rs. 4,17,476; in 1902–3 they were 21,370 lb., valued at Rs. 8,515; in 1903–4, 127,868 lb., valued at Rs. 50,722; and in 1906–7, 492,493 lb., valued at Rs. 2,13,861. The supply comes from Mekran and Sonmiani, Turkey-in-Asia, the neighbouring pastoral tracts of Southern Baluchistan, and recently from East Africa. It is consigned mainly to Sind and Bombay.

Exports.

Chief Ports, Calcutta and Bombay.

Turning now to EXPORTS, these for many years past have manifested a continuous expansion. In 1876–7 they were 1,004,661 lb., valued at Rs. 3,57,250. Twenty years later (1896–7) the figures were 3,672,349 lb., valued at Rs. 15,00,990, and during recent years for which returns are available they were in 1902–3, 6,418,045 lb., valued at Rs. 27,26,750; in 1903–4, 5,390,865 lb., valued at Rs. 22,90,825; in 1904–5, 6,097,917 lb., valued at Rs. 26,67,250; and in 1906–7, 4,884,252 lb., valued at Rs. 22,65,443. By far the most important centre is Calcutta, followed by Bombay, and the receiving countries may be said to be the Straits Settlements, Natal, Aden, Ceylon, Hongkong, Mauritius, British East Africa, Aden, etc. An effort was made some few years ago to foster the traffic in Indian produce sent to Australia, and *ghi* at that time attracted considerable attention. But the trade cannot be said to have materially expanded.

Tallow.

Animal Oils.

Soap and Candles.

Total Trade.

Other Animal Fats.—In conclusion it may be desirable to extend this brief review of the traffic in *ghi* so as to include all animal oils and fats, since these are often closely associated with *ghi*. The IMPORTS are Animal Oils, Butter, Ghi and Tallow. The traffic in the last mentioned is a large and prosperous one. In 1876–7 the imports of Tallow were 305,088 lb., valued at Rs. 62,671; in 1903–4, 2,352,224 lb., valued at Rs. 5,93,127; and in 1906–7, 4,125,744 lb., valued at Rs. 9,14,834. Next in interest are the Animal Oils, which in 1876–7 were 3,246 gallons, valued at Rs. 10,664; in 1903–4 were 389,256 gallons, valued at Rs. 4,45,217; and in 1906–7, 584,428 gallons, valued at Rs. 5,70,655. The lard and animal oils to some extent doubtless manifest the demands of the soap and candle works of India. The butter trade has been already noticed (p. 477), and need not be further mentioned. It is not known to what extent the imports of butter may in reality be margarine. But by adding the tallow, animal oils and butter to the *ghi*, the total imports of these substances were in 1903–4 valued at Rs. 14,05,602, and in 1906–7, Rs. 19,65,986. Similarly the EXPORTS may be briefly discussed. These are Animal Oils, *Ghi*, Lard and Tallow. In 1903–4 these were valued collectively at Rs. 25,52,340 (*ghi* being, as will be seen from the figures above, by far the most important article); in 1905–6 the corresponding total was Rs. 30,75,319; and in 1906–7, Rs. 23,84,765.

[*Cf. Institutes of Manu*, ii., 29; iii., 274; iv., 39, 233; v., 37, 144; vii., 131;

viii., 106, 328; xi., 92, 135; xii., 62, etc.; Linschoten, *Voy. E. Ind.*, 1598, i., 56, 58, 60, 63, 67; Bernier, *Travels*, 1658, i., 438 n., 440 n.; Fryer, *New Acc. E. Ind. and Pers.*, 1675, 33, 137; Wilks, *Hist. Sketches*, 1783, ii., 154; Chardin, *Voy. Perse, etc.*, 1811, viii., 268; Milburn, *Or. Comm.*, 1813, ii., 209; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 109; W. Crooke, *Note on Ghi*, April 1882; T. N. Mukharji, *Notes on Ghi*, 1882, 1884; Buck, *Trade with Australia in Ghi*, 1882; Schofield, *Note on Ghi*, 1886; Shroff, *Ghee Supply of Bombay*, 1887; *Ghi and Its Adult.*, in *Times of Ind.*, 1889; Basu, *Agri. Lohardaga*, 1890, ii., 44; *The Bower Manuscript* (Hoernle, transl.), 1893-7, 90-104; Lawrence, *Valley of Kashmir*, 1895, 359-60; *Ghi*, in *Ind. Med. Gaz.*, 1896; Watt, *Inaugural Address School of Pharmacy*, in *Journ. Pharm. Soc.*, Oct. 6, 1906.]

D.E.P., ii., 265; iii., 491-8. Cheese.

5. ***CHEESE.***—Cheese as known in Europe can hardly be said to be made in India (except at the modern dairy farms under European supervision). Curd or *chhena* is prepared by boiling milk and throwing into it, while still very hot, some acid milk or other acid substance (such as lime- or tamarind-juice) or a vegetable rennet; after a time it in consequence coagulates. The curdled milk is put into a cloth and the whey (*mastu*) expressed or drained away, the result being a kind of soft cheese (often called in India cream cheese). Many localities are noted for their cream cheeses, such as Hughli, Dacca, etc. Sen gives the following account of the Panakona, Sylhet, or so-called Dacca cheeses:—"As soon as the milk is taken from the buffalo, it is put in an earthen vessel and rennet is mixed with it at the rate of a seer to a maund of milk. About two hours after the curd is broken with the hand and put in small quantities in shallow bamboo baskets known as *dalas*. Next day it is mixed with a little salt and repeatedly cut across with a knife, and each time the knife is passed through it the curd is pressed with the palm of the hand. This process is repeated for three consecutive days, and altogether 2½ seers of salt are used to a maund of curd. The cheese is then left to cure. This cheese is sent to Dacca, whence it is exported as Dacca cheese. A maund of milk gives 10 seers of cheese. The price of buffalo milk here is from Rs. 3-8 to Rs. 4 a maund. The whey is kept aside for a day or two, when the oily matter floating over it is removed and made into *ghi*, and the rest of it thrown away."

Cream Cheese.
Chief Centres.
Method of Manufacture.

Lawrence says the Gujars and Pathans of Lolab make a kind of cheese they call milk-bread. He mentions an experiment in the manufacture of European cheese, and affirms that Kashmir might supply the British troops with good cheese and butter. At the Dairy Farms of Poona and Aligarh excellent cheddar cheeses have been produced (*Agri. Ledg.*, 1895, No. 5, 64). For cheese made from peas, consult Pogson (*Man. of Agri. Ind.*, 1883, 186); also see **Glycine** (p. 565). The following are the better known Indian vegetable rennets:—***Withania coagulans, Crotalaria Burhia, Leucas Cephalotes, Rhazya stricta, Streblus asper,*** and apparently also ***Carthamus tinctorius.***

Kashmir.
Poona and Aligarh.

Trade in Cheese.—The IMPORTS of cheese are much larger than might at first sight be realised, and seem on the whole to be increasing. In 1899-1900 they stood at 872,296 lb., valued at Rs. 5,34,278; in 1902-3 1,123,260 lb. and Rs. 6,18,577; in 1903-4 they had slightly decreased to 966,492 lb. and Rs. 5,34,158; but rose again in 1904-5 to 1,228,707 lb. and Rs. 6,29,274, and in 1906-7 to 1,275,111 and Rs. 7,04,487. Bombay and Bengal each receive on an average cheese to the value of 1½ lakhs. Sind takes about a lakh and Madras and Burma each half a lakh. About two-thirds of this supply is drawn from the United Kingdom, the balance from Holland, Belgium, Italy and Australia. The EXPORTS

Imports.
United Kingdom.

of Indian cheese are at the present unimportant. In 1903–4 they were 4,980 lb., valued at Rs. 2,625, and in 1906–7, 4,543 lb., valued at Rs. 2,784.

[*Cf.* Montgomery Martin, *Hist. E. Ind.*, ii., 942–3; *Mad. Exp. Farm. Rept.*, 1883, 76; Sen, *l.c.* 57; Mollison, *l.c.* 63–8; Lawrence, *Valley of Kashmir*, 1895, 360; Collis Barry, *Legal Med. Ind.*, 1903, 562.]

D.E.P., iii., 5-16.

DALBERGIA, *Linn., f.*; *Fl. Br. Ind.*, ii., 230–8; Prain, *Species Dalbergia S.E. Asia*, in *Ann. Roy. Bot. Gard. Calc.*, 1904, x., pt. i.; also in *Journ. As. Soc. Beng.*, lxvi., ii., 442; Talbot, *List Trees, etc.*, 1902, 135–8; Gamble, *Man. Ind. Timbs.*, 246–56; Brandis, *Ind. Trees*, 232–9; Cooke, *Fl. Pres. Bomb.*, i., 394–401; Duthie, *Fl. Upper Gang. Plain*, i., 263–5; LEGUMINOSÆ. A genus of tropical plants, mostly trees, that contains some 120 species, of which Prain figures and describes 86 as met with in South-Eastern Asia. Two of these (***D. Sissoo*** and ***D. latifolia***) are in India exceedingly valuable timber-trees, whilst the others are less important.

1. **D. assamica,** *Benth.*, is the *medoloa* of the tea planters (Watt and Mann, *Pests and Blights of the Tea Plant*, 1903, 141–4). 2. **D. cultrata,** *Grah.*, *yendike* or *yindaik*, is a fair-sized tree common in deciduous forests throughout Burma. It is said to exude a red resin, to furnish a useful oil, and to be utilised by the Karenis for propagating the lac-insect. The heart-wood is blackish and ebony-like, often streaked with red. It is exceedingly durable, and is used for making wheels, agricultural implements, spear-handles, etc., and sometimes for carving. 3. **D. lanceolaria,** *Linn., f.*, is the *takoli, bithúa, chakemdia, angaria, píri, chapot siris, gengri, dandous, tantosi, nal valanga, pedda sópara*, etc. A deciduous tree of the Sub-Himalayan forests from the Jumna eastward, ascending the hills to 2,500 feet; also in Central and South India and Bombay. An oil is expressed from the seeds, and the leaves and bark are reported to have medicinal properties. The timber is said to be useful in building. 4. **D. Oliveri,** *Gamble*, is the *tamalan* or *tabauk* tree of the *eng-daing* forests of Upper Burma (Wuntho and Bhamo). It attains a height of about 60 feet and girth of 4 to 6 feet. The wood is handsome, reddish, hard, close-grained, and takes a fine polish; is very like some of the South American rosewoods. It is largely used for axe-handles, dogcart shafts and other purposes for which great strength is required and is employed in the Royal Indian Marine dockyard at Mandalay for bushings to propeller-shafts, in place of Lignum-vitæ (***Guaiacum officinale***).

Blackwood.

D. latifolia, *Roxb.*; Prain, *l.c.* 80–1, pl. 62; Thurston, *Ind. For.*, 1894, xx., app.; Koorders, in *Ind. For.*, 1894, xx., 282; Watt, *Ind. Art at Delhi*, 1903, 100, 126–34. The Blackwood or Rosewood of Southern India, *sitsal* (or *swet-sal*, white *sál*), *shisham, sissu, sissua, satsiyar, rute, ruzerap, tali, kalarukh, ití jitengi, eruvadi, yerugudu, jitangi, biti, thodágatti*, etc. A deciduous tree fairly plentiful from the submontane forests of Nepal, Sikkim to Chota Nagpur, Oudh, the Central Provinces, Central and Western India to Southern India. It attains its greatest size in the Western Ghats, south to Wynaad and Travancore, and ascends the hills to altitudes of 3,500 feet. Gamble (*l.c.* 250) says it is found in dry forests with teak and bamboo, as well as in moist evergreen jungles. It may reach a height of 80 feet and a girth of 12 to 15 feet, but it is of slow growth, especially at first. It is easily propagated by seed and is readily self-sown.

The wood weighs from 50 to 66 lb. per cubic foot, and sinks in water before being seasoned; it has a fine handsome grain, and is exported from the forests of Kanara, Malabar and Travancore to Bombay, Kathiawar, Kach, Karachi, London, Havre, Hamburg and Chinese ports. The planks when not well seasoned have a tendency to split longitudinally.

Blackwood Furniture.

In India it is extensively used for furniture, cabinet-work, knees of vessels, agricultural implements, combs, etc., for the vases and other ornamental articles of Trichinopoly, and for the finely carved chairs, tables, etc., which constitute the well-known blackwood furniture of Bombay. The art of making this furniture was introduced many years ago, and to this day it is mainly produced by the Portuguese inhabitants. Of late, popular fancy has discarded blackwood and good specimens of the furniture are said to be scarcely procurable. But most famous perhaps of all black woodwork is the Dravidian and Chalukyan carving of Madras Presidency and Mysore. If it is desired to darken the colour, this may be effected by rubbing the wood with oil until what is often spoken of as imitation ebony is produced.

Darkened with Oil.

Production.

Outturn, Trade, etc.—The outturn of this wood in Madras, as recorded in the *Madras Forest Administration Reports*, was 2,374 cubic feet in 1900–1; 6,366 cubic feet in 1901–2; 11,808 cubic feet in 1902–3; and 16,182 cubic feet in 1903–4. These are the only available statistics of outturn, sale or export. In 1895 inquiry was made in London as to prices which might be obtainable for Indian rosewood. A report was subsequently issued by Mr. J. R. Royle, at that time Secretary of the Indian Section of the Imperial Institute. It was pointed out by the English firms consulted that the wood suffered from several disabilities. It is gritty and therefore much harder in the working than other cabinet timbers; it loses its bright colour and goes almost black after being cut and exposed; it is somewhat porous, and therefore absorbs the polish to a large degree.

Disabilities.

Brazilian.

Jamaican.

London Rates.

As a rosewood it is inferior to Brazilian, though superior to that of Madagascar or Honduras, but in England it has to compete with the cheap and usually reliable rosewoods sent from Jamaica. It would, however, prove specially useful where great width is required, as for example for table-tops, large carcase ends, and mouldings. Further it has to be remembered that rosewoods of all sorts, both for furniture and decoration, are very largely subject to the caprice of fashion, and at the time of the inquiry the European demand was very small. Gamble says that the usual London rate for good timber is about £10 per ton, and that there would seem still to be scope for greater activity in utilising the English market for the sale of at least the best pieces of Indian rosewood. In the reports mentioned above, one of the firms consulted thought that "the rate should not exceed 10*d.* to 1*s.* per superficial foot cut one inch," but that quotation, allowing 58 lb. to the cubic foot, would work out to about £23 per ton for picked, ready-sawn timber, a price thus considerably above the £17 10*s.* per ton reported to have been paid for a fine piece sent to London in 1878. On the other hand, some of the reports speak of Indian rosewoods as fetching an average of only from £5 to £8 per ton, but these low prices were for large lots not specially selected. Lastly, the quotations published by the trade for May 1905 were "Rosewood £5 to £12 per ton." "But it must be clearly borne in mind that rosewood of all grades is not at present popular." "At the present time East Indian is in fair demand and stocks are not heavy." In the *Indian Forester* (*l.c.* xx., app., 3) the selling prices, from the Madras forests, were given as from Rs. 20 to Rs. 75 per ton, according to distance from the coast, but in out-of-the-way places it could not be sold even at Rs. 10 per ton; from Travancore about Rs. 1–8–0 per cubic foot good quality (= about Rs. 58 per ton); of Bombay from Rs. 30 to 50 per ton. Logs for export should not be less than 24 inches in diameter, have the sapwood removed, and be exported in the round. The length should not, as a rule, be less than 15 feet, although shorter lengths find a market.

Shisham.

D. Sissoo, *Roxb.; Notes on Changa Manga* in *Ind. For.*, 1895, xxi., 286–8; Prain, *l.c.* 57–8, pl. 34; Eardley-Wilmot, *Ind. For.*, 1898, xxv., app. The *sissoo, shisham, sissu, shisu-kát, tálí safeda, shín, nelkar, shewa, zagar, tanach, yette, karra, biridi, sínsapá*, etc. A deciduous tree of the Sub-Himalayan tracts from the Indus to Assam, ascending to 3,000 feet, but probably nowhere in India strictly speaking indigenous. Gamble remarks that it is often, however, gregarious on the banks of sandy, stony, torrential rivers. On higher lands it may grow, and grow well, though not gregariously unless planted. Cultivated and often self-sown on the plains of India. But even when the trees are growing close together the shade given is light, hence *sissu* is an important shade-tree with tea planters of Dehra Dun. The seed on germinating at once makes a great length of root compared to its growth above ground, a circumstance that greatly minimises the chance of its being swept away when spontaneous germination takes place within the sandy and stony beds of rivers.

Propagation.

Quality of Timber.

Growth Quick.

Sissu coppices well and reproduces itself freely from suckers. Artificially it is best grown from seed deposited in suitable positions, because transplantation is sometimes difficult and the young trees have to be protected till fairly established. It grows most luxuriantly on low-lying sandy tracts and has been successfully raised on irrigated lands, *e.g.* at Changa Manga in the Panjáb, at Shahdera near Lahore, etc. But it is reputed that the timber of trees raised under irrigation is of poor quality and subject to serious damage by fungi. When young the growth of *sissu* is very quick; it is said to attain 2½ feet of girth in twelve years, but as it gets older its growth gets slower. The full height of a tree is about 60 feet or so, and in girth it is rarely more than 6 feet. It is very successfully grown in Sind, and is said to be the best hardwood of the Panjáb.

Uses.

Gun-carriages.

Important.

Wood-carving.

The wood is very durable, seasons well and does not warp or split. It is highly esteemed for all purposes where strength and elasticity are required, as, for example, agricultural implements, wheelwrights' work, frames of carriages, boat-building, etc. At one time it was extensively employed for gun-carriages, but owing to the limited supply of the timber it is now very little used for that purpose. It is one of the finest timbers in India for furniture and wood-carving, and is in regular demand all over the North of India. In Upper India the *shisham* wood (***D. Sissoo***) replaces very largely the rosewood (***D. latifolia***) of Western and Southern India. It attains its position of greatest importance in the United Provinces, the Central Provinces and the Panjáb, being replaced on the north by *deodar* and to the south by *sál* and rosewood. The wood-carving of Saharanpur, Farakhabad, Lucknow and Nagpur and the inlaid work of Chiniot, Hoshiarpur, Jallandhar and Mainpuri are largely on *shisham*. In Rajputana also, this wood is to a considerable extent employed by the wood-carvers, but for particulars of the methods of treatment and styles of carving the reader should consult *Indian Art at Delhi*, 1903 (103, 108–9).

Sleepers.

Owing to the fact that the *sissu* very rarely grows straight, the timber is not of much use for beams though it is in much demand for knees of boats. It has been successfully tried for railway-sleepers, is an excellent fuel and makes very good charcoal, but it is too expensive to be utilised for these purposes. The wood is said to yield an empyreumatic medicinal oil, and the raspings of the wood are officinal, being regarded as alterative. Near towns the tree is largely lopped for fodder and the fallen leaves collected and valued as fuel by the sweetmeat makers.

D.E.P.,
iii., 19–26.
Nepal
Paper.

DAPHNE, *Linn.*: *Fl. Br. Ind.*, v., 193–4; Collett, *Fl. Sim.*, 1902, 435; Gamble, *Man. Ind. Timbs.*, 577; THYMELACEÆ.

There are two or three shrubs of economic value which belong to this genus:—1. **D. cannabina,** *Wall.*, is the most important and may be spoken of as one of the best Nepal Paper Plants. It occurs on the temperate Himalaya from Chamba to Bhutan, at altitudes of 3,000 to 8,000 feet. It is the *setburwa, setburosa, satpura, dunkotah kaghuti, dhak chamboi, chamboi, barua, niggi, jeku,* etc. 2. **D. involucrata,** *Wall.*, is the *chota aryili* and is met with in Sikkim, the Khasia hills and Tenasserim, and in the countries where at all abundant it is used similarly to ***D. cannabina***. 3. **D. Mezereum,** *Linn.*, is not indigenous to India, but is often mentioned by Indian medical writers and is perhaps imported and sold by the drug dealers. 4. **D. oleoides,** *Schreb.*, is a small plant met with in the Western Himalaya from Garhwal to Afghanistan. It is best known by the following names—*kútilál, kanthan, gandalún* (*gandalinu*), *laghune, pech, pirkai buta,* etc. The roots are boiled and given internally as a purgative; the bark and leaves are also said to be used medicinally; the berries are reputed to induce nausea, and according to Brandis, a spirit is distilled from them in the Sutlej valley. It is just possible, therefore, that this may be the *Mezereon* of Indian medical writers. It is commonly reported that camels will not eat it and indeed that it is poisonous to them.

D.E.P.,
iii., 202.

5. **Edgeworthia Gardneri,** *Meissn.*; *Fl. Br. Ind.*, v., 195 is a closely allied plant to the species of ***Daphne***, and one which would seem to be an even more important

source of Nepal paper than ***D. cannabina.*** It is a large elegant bush of the Central and Eastern Himalaya from Nepal to Bhutan, Manipur and Burma—distributed to China and Japan. It is known in India as the *kaghuti, aryili,* etc., and might be called the true Nepal paper plant. The *mitsumata* of Japan, and, according to Hemsley (*Journn. Linn. Soc.*, xxvi., 401), is ***Edgeworthia chrysantha.*** It is regularly cultivated in that country for its paper bark.

Nepal Paper.

Nepal Imports.

NEPAL PAPER.—Quite recently Stein (*Ancient Khotan*, 1907, 426) has announced the discovery of an actual specimen of Daphne paper, the date of which has been determined as the middle of the 8th century. This was found in the ruins of Endere and was examined both microscopically and chemically by Prof. J. Wiesner. The material was found to be a well-macerated fibre of the ***Thymelaceæ***, presumably ***Daphne.*** From the fact of no ***Daphne*** being known to occur in Eastern Turkestan, it has been inferred that the paper had been made in Tibet. [*Cf.* Wiesner, *Denkschr. Akad. Wiss. Wien., Math.-Nat.*, lxxii., 17–8.] It is thus permissible to regard this as the oldest recorded sample of what is commonly spoken of as "Nepal Paper." But even during the beginning of the 19th century, Nepal did not produce enough Daphne paper to meet the demands of India. Buchanan-Hamilton (*Acc. King. Nepal*, 1819, 232–3) tells us that the local supply did not suffice and that Nepal had to import both the paper and the raw material from Tibet. Kirkpatrick (*Acc King. Nepaul*, 1811, 80) speaks of one of the two species seen by him as being the paper-plant of Tibet. It would thus be more correct were the paper in question called "Tibet Paper," and this change in name would be in direct accord with the discovery narrated by Stein. [See **Paper and Paper Materials**, p. 862.]

Botanical Account.

It is perhaps hardly necessary to repeat that there are two important plants from which the so-called Nepal paper is made:—(*a*) ***E. Gardneri*** and (*b*) ***D. cannabina.*** Perhaps the earliest account by a botanist of this paper-material is that given by Wallich, who figures and describes three species and tells us that ***Edgeworthia*** was regularly cultivated in Nepal for its paper-yielding bark. In 1837 Lord Auckland, while Governor-General of India, called for further information, and various reports were in consequence prepared and submitted to the Government of India. Atkinson and other more recent writers repeat the statement that the Bhot country sends to this day large supplies into Nepal. Still, however, no material progress has been made, and Nepal paper is no nearer than it was a hundred years ago to becoming a commercial commodity. In fact it may be doubted whether any bark fibre is ever likely to be of value, unless for very exceptional purposes; it is too expensive as a modern paper-material. Nepal, Kumaon and Sikkim are the chief regions where India's supply of the so-called Daphne or Nepal paper is obtained. The reader should consult **Broussonetia**, p. 186, and **Paper Materials**, p. 868, for further particulars. [*Cf.* Wallich, *As. Res.*, 1820, xiii., 383–90 and 3 pl.; Lace, *Journ. Linn. Soc.*, 1891, xxviii., 312; Morris, *Cantor Lect.* in *Journ. Soc. Arts*, 1895, lxiii., 938; Dodge, *Useful Fibre Plants of the World*, 1897, 146; Kanjilal, *For. Fl. U. Prov.*, 1901, 281; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 432; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 121–2.

D.E.P., iii., 28–9. Akalbir.

DATISCA CANNABINA, *Linn.*; *Fl. Br. Ind.*, ii., 656; *Pharmacog. Ind.*, 1891, ii., 98; Bentham, *Rev. Cenni Storici of Targioni-Tozzetti* in *Journ. Hort. Soc.*, 1855, ix., 152; DATISCACEÆ. The *akalbir, akalbar, kalbir, bhang-jala, bajr, waftangel* (*waft-tanj*), *drinkhari, sida atsu*, etc.

A tall erect herb resembling hemp, met with in the temperate and sub-tropical Western Himalaya from Kashmir to Nepal. Root extensively used in India as a yellow dye for silk. It is largely exported from Kumaon, Garhwal, Bashahr and Kashmir, and is mentioned in 1594 as a useful plant found in Crete. [*Cf.* Hummel and Perkin, *Journ. Soc. Chem. Indust.*, 1895, xiv., 458; *Imp. Inst. Tech. Repts.*, 1903, 215–6.]

D.E.P., iii., 29–43. Datura.

DATURA, *Linn.*; *Fl. Br. Ind.*, iv., 242–3; *Pharmacog. Ind.*, ii., 584–624; iii., 182–90; Prain, *Beng. Plants*, ii., 751; Cooke, *Fl. Pres. Bomb.*, ii., 273; SOLANACEÆ.

History.—The vernacular names given to the species of this genus can hardly be said to distinguish the various forms that exist. The Sanskrit names

Doubtfully Indigenous.

dhustura or *dhattura* and *unmatta* mean "insane," and hence might have been given to an introduced plant (on its properties being recognised); in fact might be upheld as not necessarily involving an ancient knowledge. The better known vernacular names are either derived from the above or have meanings in the languages to which they belong that denote the well-known properties of the drug. As met with in India the species of **Datura** have the appearance of introduced plants. They frequent waste lands near human dwellings or invade the borders of fields or cover abandoned cultivation. They do not exist as individual plants that take their own positions in a blended vegetation, but appear as invading cohorts and here and there become so abundant as to exterminate all other plants. No form of Datura exists, in fact, under such conditions as to justify the emphatic opinion that it is indigenous to India.

The White- and the Purple-flowered Forms.

It is customary to read of "the white-flowered *datura*" and of "the purple-flowered *kala-datura*" as if these conditions implied specific distinctions. Not only so but many writers affirm that the purple-flowered form is a more deadly poison than the white, but that belief doubtless rests mainly on the theory of signatures. Any of the Indian forms may have white or purple flowers, may have single or double flowers, and may have thorny or smooth fruits. How far the chemical properties of these plants are affected by cultivation, by soil or by climate, it is at present impossible to discover. One thing, however, is certain, that the Daturas have been, and to some extent are still, cultivated plants, so that the differences recognised between the so-called wild plants of one region and of another may be due to their being more recent escapes from a special cultivation. Possibly all the Indian forms constitute but one or at most two species. **D. Stramonium** might be called the type of the temperate and alpine series and **D. fastuosa** that of the tropical assemblage.

Temperate and Tropical Forms.

Ancient Knowledge.

Beverages.

Criminal Uses.

But if the Daturas are only introduced plants, their properties have in India been fully understood for many centuries. The account published by Garcia do Orta in Goa during 1563 of the criminal uses to which they are put, might be reprinted as a statement of the nefarious practices of to-day. So also the investigations of the Hemp Drugs Commission might be summarised as the discovery that if taken in moderation *bhang* is harmless, but when mixed with Datura, that intoxicant becomes most reprehensible and even dangerous to life. Moreover the seeds are known to enter into the composition of certain alcoholic beverages and render the consumers of these literally mad. Some years ago I witnessed a remarkable process of making *arak* (country spirit) potent. A few seeds of Datura were burned on a charcoal fire, an empty earthen pot was held the while over the fumes. When full of smoke *arak* was poured into the jar, the result being its adulteration with the active principle of Datura in a form that would most likely escape detection by any ordinary process of examination (see **Spirits**, p. 1047). The extent to which Datura seeds are used criminally in India can be readily judged of by the perusal of the annual reports of the medical examiners to the various Governments and Administrations of India. These literally teem with particulars of Datura-poisoning.

The following particulars of the chief forms may assist in their recognition:—

Datura fastuosa, *Linn.; Hummatu,* Rheede, *l.c.* 47. The *kala dhatúrá, khunuk, toradana, údah-dhatúrá, karu-umate, nalla-ummetta, kechubang,* etc., etc. A small shrub found all over the tropical parts of India; the most common and abundant species. The capsule is retained in a nodding attitude and opens irregularly near the apex. There are said to be several recognisable varieties of which ***D. alba,*** *Nees* (the *saféd-dhatura*) is that most frequently mentioned and most highly approved medicinally. It has the flowers often creamy-white, but is doubtfully separable from the type.

Medicinal Form.

D. Metel, *Linn.*—This is found chiefly on the N.W. Himalaya and the mountains of the Deccan.

Temperate Form.

D. Stramonium, *Linn.*—Is met with on the temperate Himalaya from Baluchistan and Kashmir to Sikkim. The capsule is erect and deeply four-valved. This seems far more likely to be the white Datura of medical writers than *var. alba* above. It is described as the *tattur* of the Panjáb and the *kachola* of Afghanistan. Lawrence (*Valley of Kashmir*, 1895, 77) mentions that Kashmir exports the seeds largely to the Panjáb and that they fetch Rs. 5 a maund. The *var. Tatula* appears to be the plant of which the dried fruits (strung on thread) are sometimes imported into India from Persia. These imported fruits are sold under the name *yharbhúli* in Bombay and *maratia múghú* in Madras. Poisoning from eating *tatuleh* is recorded in the *Kew Bulletin* (1889, 275–8; 1896, 233).

Medicine.

The MEDICINAL uses of the species of *Datura* centre chiefly in their poisonous property and in the pernicious and criminal advantage often taken of these all too prevalent plants. Barry points out that the seeds of *Datura* may be mistaken for those of *Capsicum*. Reduced to a powder they are criminally mixed with food and can often only be detected through the microscopic structure of the fragments of the seed-coat that may be discovered in the food or the contents of the stomach.

Detection.

[*Cf.* Garcia de Orta, 1563, *Coll.*, xx.; Acosta, *Tract. de las Drogas*, 1578, 87; Linschoten, *Voy. E. Ind.*, 1598, i., 210–1; Pyrard, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 113–4; Herbert, *Travels*, 1677, 337; Fryor, *New Acc E. Ind. and Pers.*, 1675, 32; Rheede, *Hort. Mal.*, 1679, ii., 47–52, tt. 28, 29, 30; Rumphius, *Herb. Amb.*, 1750, v., 246–52, t. 87; Ainslie, *Mat. Med. Hind.*, 1813, 47; Chevers, *Man. Ind. Journ.*, 1870, 179 *seq.*; *Rept. Ind. Hemp Drugs Comm.*, 1894, i., 172; *Brit. and Colon. Drugg.*, 1898, xxxiii., 769; Dunstan, *Trans. Chem. Soc.*, 1901, lxxix., 71–4; Bedford, *Ind. Med. Gaz.*, 1902, xxxvii., 206–10; Mehta, *Ind. Med. Gaz.*, 1904, 20; Collis Barry, *Legal Med. Ind.*, 1903, 473–4; White and Humphrey, *Pharmacop.*, 1901, 470; *Ann. Repts. Chem. Exam.*, 1897–1905.]

D.E.P., iii., 43-52. Carrot.

DAUCUS CAROTA, *Linn.*; *Fl. Br. Ind.*, ii., 718; Roxb., *Fl. Ind.*, ii., 90; *Rec. Bot. Surv. Ind.*, ii., 107; Prain, *Beng. Plants*, i., 540; Duthie, *Fl. Upper Gang. Plain*, 398; UMBELLIFERÆ. The Carrot, *gáger, mormújh, kách, zárdak, manjal-mullángi, kárttu-kizhangu, píta-kanda*, etc.

Distribution.

Habitat.—A native of Kashmir and the Western Himalaya at altitudes of from 5,000 to 9,000 feet. It is also commonly held to be a native of Europe (except the extreme north), of Abyssinia and North Africa, of Madeira and the Azores, and of North Asia eastwards to Siberia and Kamschatka. Throughout India it is cultivated by the Europeans, mostly from annually imported seed, and by the Natives from an acclimatised if not indigenous stock. In many parts of the country a greenish-white carrot is preferred as being very hardy and productive. This rises some two or three inches above the soil, is a coarse root which possesses little of the flavour of the European carrot, but is able to withstand the extreme heat of summer, and may be raised in some parts of the country throughout the year. It thus produces a return at seasons when other tubers or roots are scarce or not available. This is particularly the case in Bihar (Patna) and some parts of the United Provinces.

Indian Form.

History.

History.—Sir George Birdwood (*Memo. Carrot for Famine Relief in N. Ind.*, 1896) gives a detailed and learned account of the history of this plant. This occupies many pages, and can hardly be abbreviated without greatly lessening its value. The carrot appears to have been regularly used in India from fairly ancient times. The Emperor Baber (*Memoirs*, 1519 (Leyden and Erskine, transl.), 1826, 347) narrates his having eaten a dish of fried carrots. In the *Ain-i-Akbari* (Blochmann, transl., 63-4, 67) mention is made of "wild carrots" (*shaqaqul*) and of cultivated carrots. Terry (*Voy. E. Ind.*, 1655 (ed. 1777), 91-2) speaks of the good carrots of Surat, and Fryer (*New Acc. E. Ind. and Pers.*, 1672-81, 119) makes special mention of those of the Deccan. While much reliance cannot be placed on names of plants as historic evidences, it is significant that throughout the languages of India, indeed from Central Asia to Cape Comorin, there should prevail in every language a name for the carrot (*gáger, gájar, gázara, garjara*, etc.) which seems to have come from a common source. To that name is frequently added a further word meaning "root" or "tuber." Thus in Tamil it is the *gajjara-kellangu.* The derivation of the Latin name *carota* and of the French *carotte* is probably direct from the Greek *karoton.* The Sanskrit *garjaru* originated the Persian *zardak* and the Arabic *jegar.* In fact, the evidence of cultivation would lead to the inference that the carrot spread from Central Asia to Europe, and if so it might be possible to trace the European names from the Indian and the Persian. Indeed the carrot seems to have been grown and eaten in India while in Europe it was scarcely known as more than a wild plant. In Anglo-Saxon it was *weal-mora, wald-mora, walck-mora, clap-wype,* but it was confused with the parsnip till about the end of the 11th century. These names recall the German *mohre, moraha,* the Russian *morkov,* the Sanskrit *mula, mulaka,* and the Kashmiri *mor-mujh,* and they all denote "root."

Bengal.
Sowing Season.
Imported Forms.
Yield.
Seed Required.

Cultivation.—Bengal.—A writer in *Indian Gardening* (Oct. 27, 1898) says in his experience (in Chumparan) the seed should be sown broadcast early in November. Of the imported varieties the Large White Vosges and White Belgian succeeded best. The crop continued to yield till the end of May. Other writers in the Northern and Central portions of the province speak of sowings in August and the crop coming into season in January and February. Mukerji (*Handbook Ind. Agri.,* 1901, 357) observes that the carrot has a special value as a nourishing famine food and fodder. The Red Mediterranean variety grown at the Cawnpore Experimental Farm seems to be the best. The Yellow Mediterranean is most highly spoken of as a cattle food. The yield of the White Mediterranean carrot is almost equal to or even higher than that of country carrots, but the roots are hard, coarse and insipid. When grown without manure the country carrot gives a much larger yield than any of the European varieties. The proper time for sowing carrot seed in the plains is from September 15 to October 15. It is best to sow in drills and ridge the drills after the plants have appeared, then thin out. The quantity of seed used is 8 to 12 oz. an acre. The yield comes to 200 to 500 maunds per acre, if loose soil near the village be chosen, deeply cultivated, well pulverised, weeded and irrigated. The seed had better be mixed with wood-ashes at the time of sowing, and unless the soil is quite moist, water should be poured in the drills immediately after sowing. [*Cf.* Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 166–7.]

U. Prov.
Area.
Season.
Yield.

United Provinces.—Duthie and Fuller (*Field and Gard. Crops,* 1893, pt. iii., 9) say the area occupied by the carrot is not separately estimated in the agricultural returns, but the average under carrots, turnips and radishes for the three years ending 1889–90 amounted to 41,463 acres. The carrot is generally sown in September or October; the roots are ready for use after two months, and may last for three or four months. A loamy soil is preferable. Under favourable conditions an outturn of over 200 maunds is possible. At Cawnpore 60 maunds is said to be the average, but at Basti only 33 maunds. The bazár price in ordinary seasons is from 8 to 16 seers an anna.

Panjáb.

Panjáb.—Brief notices are made of carrot cultivation in the Panjáb. In Jhang it is said "the zamindar's food consists largely of carrots" (*Replies Famine Comm.,* 228). In Sialkot (*Gaz.,* 68) the carrot is spoken of as grown all over the district, and the superior European kinds are little known.

Bombay.
Two Crops.
Transplanted.

Bombay.—Of Gujarat it has been said that carrots of two kinds are cultivated—"the long-rooted" and the "blunt spindle form." They are grown at various times in different parts of the province, generally in garden beds from seeds sown broadcast, but are sometimes transplanted from nurseries during the *rabi* season. They take three months to mature, Yield. Method of Seeding.

though by nipping off the heads growth may be prolonged. The young plants are also taken up when half grown and sent to market. The produce is from 5,000 to 10,000 lb. an acre. The carrot is also grown in Gujarat from August to May, and the crop gathered four months later. In Kach it is much raised as a field crop. In Poona and Khandesh the carrot is cultivated very largely on black soil, with the help of manure. Of Ahmednagar a curious process is reported of obtaining carrot seed: When the crop is ready the husbandman cuts off a thick slice from the crown end of the carrot. This he puts two fingers deep below the soil in any place where there is a liberal supply of water. After a few weeks the roots produce a vigorous flower stem, the seed of which is gathered four or five months after having been thus transplanted. There are accordingly two crops in the year—one, the root produced from the seed, the other the seed produced from the root (see **Raphanus sativus,** *var.* **caudata,** p. 912). In the Deccan, according to Woodrow (*Gard. in Ind.*, 1889, 340), the carrot may be grown as a culinary vegetable where the rainfall is not over 25 inches annually, during the rainy season. Large sowings for fodder should be made in October and November, and if late rains are favourable good crops may be grown on a deep retentive soil without irrigation.

Mysore.

Mysore is stated to produce a very good quality of carrot, but in Madras and Burma the root seems to be raised only as a garden vegetable.

Vegetable. Cooking.

Food and Fodder.—The so-called root constitutes an important vegetable in the markets frequented by the European community. Although certain classes of Hindus in Bengal object to eat the carrot, on account of some fanciful resemblance to beef, still the Natives of India, as a whole, are year by year taking more kindly to it. At the same time it must be added that, though by the Muhammadans and certain Hindus the carrot has been cultivated for ages, it is only within recent years that it has become a recognised article of diet. By certain classes the young carrots are used only as pickles. By others "the root is first boiled in water, then squeezed out and cooked in *ghi*." In Europe it has become a recognised article of cattle food. Carrot-tops afford a useful fodder, and the contention that the roots might be resorted to in times of famine is strengthened by the fact that the tops would be of value to the cattle. [*Cf. Agri. Ledg.*, 1898, No. 12.]

Medicinal.

Seed.—The seed yields by distillation a medicinal oil. [*Cf. Taleef Shereef* (Playfair, transl.), 113.] In the Hemp Drugs Commission Report (iv., 415) mention is made of the seeds constituting one of the spices used in flavouring *bhang*. Lawrence (*Valley of Kashmir*, 67) says carrot seeds are employed to mix with caraway. The chemical constituents of the root are crystallisable and uncrystallisable sugar, a little starch, gluten, albumen, volatile oil, vegetable jelly, malic acid, saline matters, lignin and a peculiar crystallisable, ruby-red neutral principle, without odour or taste, called *carotin*. [*Cf. Pharmacog. Ind.*, ii., 136.]

D.E.P., iii., 65-9.

DELPHINIUM DENUDATUM, *Wall.; Fl. Br. Ind.*, i., 25; RANUNCULACEÆ. The *nirbisi* or *jadwar* of certain writers (names that more strictly speaking denote species of ***Curcuma*** or of ***Aconitum,*** which see); is also the *múnila* of the North-West Himalaya. **D. saniculæfolium,** *Boiss.*, has been supposed by some, but incorrectly, to afford the *asbarg* dye and medicinal flowers.

D. Zalil, *Aitch. & Hemsl.*, an abundant larkspur in Khorasan at altitude of 3,000 feet, where its spikes of golden flowers give a wondrous hue to the pasturage. It is the *asbarg* dye and medicine of Indian shops.

The dried flowers and fragments of the flowering spikes constitute the *asbarg.* It is the *ghafiz, asperag, gul jalil, zalil, zarir, trayamán,* etc. Is imported by Trans-frontier traders, who bring it to Multan and other Panjáb towns where it is employed along with *akalber* and alum to dye silk. [*Cf. Pharmacog. Ind.*, i., 23-7 ; *Kew Bull.*, 1895, 167 ; Brühl, *Ann. Roy. Bot. Gard. Calc.*, 1896, v., pt. 2, 90-108 ; *Monog. Dyes and Dyeing in Bomb.*, 1896, 17 ; also *U.Prov.*, 1896, 82 ; Perkin and Pilgrim, *Trans. Chem. Soc.*, 1898, 267-75 ; also *Proc. Chem. Soc.*, 1898, No. 190 ; *Imp. Inst. Tech. Repts.*, 1903, i., 214 ; ii., 221.]

D.E.P., iii., 115-36. Yams.

DIOSCOREA, *Linn.* : Watt, *Sel. Rec. Govt. Ind.*, 1888-9, i., 147-66 ; Duthie and Fuller, *Field and Gard. Crops*, 1893, pt. iii., pl. lxxx. ; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 68-71 ; Wiesner, *Die Rohst. des Pflanzenr.*, i., 567-608 ; Mollison, *Textbook Ind. Agri.*, iii., 197-200 ; Prain, *Beng. Plants*, 1903, ii., 1064-7 ; Ryan, *Journ. Bomb. Nat. Hist. Soc.*, 1903, xiv., 772-5 ; R.E.P., *Rept.* 1903, 27-8 ; Prain and Burkill, *Journ. As. Soc. Beng.*, 1904, lxxiii., pt. ii., 183-7 ; 1904 (suppl.), 1-11 ; the YAMS—DIOSCOREACEÆ.

Indian Species and Varieties.—The account given in the *Dictionary* of this very difficult and imperfectly known genus of edible plants was written in 1888. It was subsequently arranged by the Government of India that a concentrated effort should be made to secure fuller and more accurate information. Collections of live tubers, accordingly, began to arrive in 1894, and continued to be received during the subsequent years. It was agreed that the yams as received should be cultivated in the Royal Botanic Gardens, Calcutta. They are therefore being systematically studied. A preliminary and unofficial report has already appeared, written by Prain and Burkill, and descriptions of certain species have been given in the *Journal of the Bengal Asiatic Society*, but further material and more detailed information are deemed essential before the final report can be given to the public, and this seems likely to assume the form of a monograph of the Indian species of the genus. All that need be attempted here, therefore, is to abbreviate the *Dictionary* article, and to abstract and incorporate from Prain and Burkill's preliminary report (and all other recent publications) such additional information as seems calculated to bring the present account abreast of existing knowledge.

Prain (*Bengal Plants, l.c.*) sketches very briefly the classification that seems likely to be followed in the future. The Bengal species are referred to two great groups according as the stems twine to the left or to the right of the observer. This brings the following together as those that twine to the left—***D. dæmona, pentaphylla, tomentosa, bulbifera, deltoidea,*** and ***fasciculata*** ; those that twine to the right, ***D. anguina, aculeata, nummularia, Hamiltoni*** and ***alata.*** Within these groups the species are assorted according to the characters of the leaves, inflorescence, capsules, seeds and aerial bulbs. It may be useful to set forth in alphabetical sequence of their names the economic information of the chief Indian species and varieties :—

D.E.P., iii., 131.

D. aculeata, *Linn.* ; Prain, *l.c.* ii., 1067 ; *D. glabra, D.E.P.* ; *D. Wallichii, Hook., f., Fl. Br. Ind.*, vi., 295. A plant cultivated in Bengal, Assam, the Deccan, South India and Burma ; in the last province it is apparently also wild.

D.E.P., iii., 126-7. Barbados Yam.

D. alata, *Linn.* ; *Fl. Br. Ind.*, vi., 296 ; Prain, *l.c.* 1067 ; *Rec. Bot. Surv. Ind.*, ii., 143 ; iii., 288 ; *Circ. Roy. Bot. Gard. Ceylon*, 1905, iii., 10-4. The Wing-stalked Yam, the Barbados Yam, *kham.* This seems closely allied to the Chinese yam, ***D. Batatas,*** *Decaisne.*

Commonest Indian Yam.

This is the commonest of all the Indian cultivated yams. It is a large climber with quadrangular winged stems which twine to the right. The capsule is broader than long and the seeds winged all round. Leaves rather sharply angled. Inflorescence only occasionally produced and often zig-zag in structure. Tubers frequently very large, sometimes four to eight feet in length and as thick as the thigh (*Conserv. For. Repts. S. Circ. Mad.*, May 1889), at other times small and globular like an average-sized potato. One or two species of yam are frequently alluded to in Sanskrit literature, and this would appear to be perhaps the form most often mentioned. Roxburgh assigned four or five tubers to sepa-

Distinctive Races.

rate specific positions, chiefly on account of their shape and colour. He, however, admitted that he would be quite prepared to accept all these races (for they appear to be little else than races) as belonging to the same species. These were ***D. atropurpurea, globosa, purpurea*** and ***rubella*** (*Roxb., Fl. Ind.*, iii., 797–801). They are classified into tubers elongate, at times club-shaped, the flesh being white throughout in ***alata*** proper, pink under the skin in ***rubella***, purple throughout in ***purpurea***; tubers short, roundish, and flesh wholly white in ***globosa***; rosy purple under the skin in ***globella***, and rosy purple in ***atropurpurea***. J. D. Hooker places these names as denoting "imperfectly known and undeterminable species." Prain and Burkill, however, after a careful study of the live plants, have recorded Roxburgh's four forms above named under ***D. alata***, *Linn.*, and have formed varietal positions for each (*Note, l.c.* 1903–4, No. 846). These are as follows:—

White Yam.

(*a*) **Var. alata** proper; *D. Hamiltoni, Hook., f.* (in part). The White Yam. This is said to be a large climber, fairly abundantly cultivated in Bengal, Assam, the United Provinces, the Central Provinces, the Deccan, South India, Burma and Ceylon. It varies very greatly, however, in some of its areas.

Common Yam.

(*b*) **Var. globosa**; *D. globosa, Roxb.*, Duthie and Fuller, *Field and Gard. Crops*, pt. iii., 11; *D. globosa, D.E.P.*, iii., 131; the Common Yam. This also is a large climber that is fairly extensively cultivated, more especially in the Central Provinces and Madras. It is the *chupri-alu, fergo-nari*.

Long Red Tuber.

(*c*) **Var. rubella**; a large climber, extensively grown, especially in Bengal, the Central Provinces, Western India and the Deccan. It yields a long tuber, red outside, known as the *guraniya-alu*.

Dark Purple Yam.

(*d*) **Var. purpurea**; the Dark Purple Yam: the Malacca Yam, or *lab-guraniya*. A large climber fairly extensively cultivated.

D.E.P., iii., 127.

D. anguina, *Roxb.*; *Fl. Br. Ind.*, vi., 293; Prain, *Beng. Plants*, ii., 1066. A large climber met with occasionally in the forests and jungles of the lower hills in Nepal to Bhutan, also Chota Nagpur and Assam. The tuber is only eaten by the poor or in times of scarcity, and is called *kukur-alu*.

D.E.P., iii., 128–9.

A Wild Yam.

D. bulbifera, *Linn.*; *D. sativa, Benth.*; *D. pulchella* and *D. crispata, Roxb.*; Hermann, *Parad. Bat.*, 1698 t. 217; *D. sativa, Willd.* Duthie and Fuller, *Field and Garden Crops*, pt. iii., 11, t. lxxx.; *D. sativa, Linn.* Hooker (Trimen, *Fl. Ceyl.*, iii., 279) calls this "the wild uneatable state of the cultivated plant." This fairly extensive climber is common in the hedges and thickets of India and Burma. It is a distinct species, the capsule being longer than broad, and the seeds winged at the base only; the leaves are bright shining green and the transverse nerves rest within channels. The tubers are round, not larger than a man's fist. The stem, like that of ***D. alata***, bears numerous little tubers by which the plant may be propagated. The aerial tubers also afford characters by which the varieties may be separately recognised. The underground tubers of the wild plant are insipid and often hardly edible, unless repeatedly boiled and washed in running water between each boiling. Nevertheless, the wild forms collectively constitute a fairly important article of food in times of scarcity and famine. [*Cf.* Acosta, *Tract. de las Drogas*, 1578, 321.]

Famine Food.

Otaheite Potato.

(*a*) **Var. bulbifera** proper.—The agricultural states of this variety are often designated in India as ***D. sativa***, and the recently introduced forms are spoken of as the Otaheite Potato. The wild tubers are regularly eaten, though more bitter than the cultivated. An interesting official correspondence recently took place regarding the successful conveyance (by Capt. H. D. Larymore) of seed-tubers of the so-called Otaheite Potato from the Andaman Islands to West Africa.

D.E.P., iii., 128.

(*b*) **Var. pulchella**; *D. pulchella, Roxb.*; *D. sativa, Linn.*; *Fl. Br. Ind.*, vi., 295 (in part); *D. bulbifera, D.E.P.* A climber fairly generally met with in cultivation. It is in India often known as the *rát-alu*.

D.E.P., iii., 129.

(*c*) **Var. crispata**; Roxb., *Fl. Ind.*, iii., 802. A fairly prevalent climber in India and Burma, known as *zamin-kand*.

D.E.P., iii., 129.

D. deltoidea, *Wall.*; Prain and Burkill, *Journ. As. Soc. Beng.*, 1904, lxxiii., pt. ii., suppl., 1–2, 5–6. This is a common species in the N.W. Himalaya at altitudes between 3,000 and 8,000 feet—flowering time in May. It is an extensive climber, often covering trees more or less. Stewart gives a long list of vernacular names which in the *Dictionary* it was suggested belonged to all the species met with in Upper India. Even to the present day a distribution of these names has not been accomplished. The tubers are often very large, but apparently not eaten. In Kullu they are called *shingli*, and used for washing wool. Stewart says that in Khayhan they are called *kriss* and used in

Detergent Tubers.

washing silk. Lawrence (*Valley of Kashmir*, 75, 78) calls them *krits* (or *kritz*), and remarks that they are much used in washing wool and also in medicine. The same tubers, according to Atkinson, are in Kumaon known as *gun*. Some writers appear to regard them as poisonous.

D.E.P., iii., 129. Wild Yam. Famine Food. Intoxicating. Poisonous.

D. dæmona, *Roxb.; Fl. Br. Ind.*, vi., 289; *Rec. Bot. Surv. Ind.*, 1898, i., 274; 1903, ii., 143, 189. A large climber of the tropical forests of India and Burma. Stems twining to the left, sometimes prickly; leaves digitately 3–5 nerved; capsule longer than broad and seeds winged at the base only. This wild yam is extensively used as a famine food, chiefly in Burma and the Central Provinces and Central India. It appears never to have been cultivated. Some writers, however, say the roots are highly poisonous and cause intoxication but are rendered edible by boiling and steeping in running water, this treatment being repeated two or three times. Gammie (*l.c.* 190) says that when tigers kill cattle, the villagers insert a quantity of the flour from the pounded roots of the *vaja kand* into the body of the "kill." The poison permeates the flesh to such an extent that when the tiger returns and eats the carcase it becomes infatuated and mad, and the villagers then make short work of it. Ridley (*Malay Pl. Names*, in *Journ. Roy. As. Soc.* (*Straits Branch*), 1897, 90) speaks of the tubers being used in the manufacture of dart poison. (*Yearbook of Pharmacy*, 1898, 62–3).

D.E.P., iii., 130. Karen Potato. *Pindalu.*

D. fasciculata, *Roxb.;* Prain, *Beng. Plants*, 1903, ii., 1066. The kidney-shaped yam, Karen Potato. A small climber somewhat like ***D. alata*** but more graceful; of a vivid green colour, the stem twining to left and dotted over with small wart-like prickles. Leaves pubescent reniform or orbicular with sharp stipular thorns. Tubers fasciculate, numerous, usually white, but in Burma and the Malay Islands a form exists which has reddish-coloured tubers. This is obviously derived from the wild ***D. spinosa***, which differs only in the fact that the upper rootlets are spinose. Much confusion seems to exist regarding the name *pindalu*. In some localities of South India it denotes the white round tubers of one or two races of ***D. alata***. In other provinces it is restricted to the present plant. I found (during special investigations conducted in 1894) the latter usage throughout Berar, where the clustered yam is fairly plentiful and popular. It is ordinarily grown as a garden crop near the homestead, on stakes 8 feet high and 2 to 3 feet apart, around *pan*-leaf houses, or in fields, along with the *brinjal*. In some localities, as for example Nirmal and Bassein in Bombay, it is cultivated as a pure field crop. Roxburgh tells us that in his day it was grown to a considerable extent in the vicinity of Calcutta not only for food but to make starch. Being, in some respects, more like a potato than a yam it is often called the potato of this and that place—*e.g.* "Karen Potato."

D.E.P., iii., 131. *Ban alu.*

D. glabra, *Roxb.; Fl. Br. Ind.*, vi., 294; Prain, *Rec. Bot. Surv. Ind.*, 1905, iii., 288; *D. nummularia, Lamk.*; *Beng. Plants*, ii, 1067. So far as India is concerned, however, it would appear to be rarely if ever cultivated, though the tubers are regularly collected and eaten by the hill tribes, more especially in times of scarcity and famine. It occurs on the lower North-West Himalaya, in Nepal, Sikkim, the hills of Bengal to those of South India and Burma, distributed to the Malay Peninsula and China. It is very often called *ban* (wild) *alu* or *aru* (yam), *shora-alu*. [*Cf.* Wood, *Rec. Bot. Surv. Ind.*, ii., 143.]

D.E.P., iii., 133.

Var. belophylla, *Voigt* (*sp.*); *D. sagittata, Royle*; Prain, *l.c.* 1064. It seems probable that this should be retained as a distinct species. It is a large climber met with on the lower Himalaya and mountains of Bengal (Parisnath). The tubers are edible but the plant is not recorded as met with under cultivation.

D.E.P., iii., 131.

D. Hamiltoni, *Hook., f.: Fl. Br. Ind.*, vi., 295 (in part); Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 192; *D. globosa* (in part), *D.E.P.* This cultivated plant is occasionally met with in Bengal, Assam and Burma.

D.E.P., iii., 132.

D. oppositifolia, *Linn.: Roxb., Fl. Ind.*, iii., 804; *Fl. Br. Ind.*, vi., 292. A large climber with terete unarmed branches and with the leaves almost opposite. It is a native of tropical India from the Deccan to Assam, Sylhet, Chittagong, Burma, Ceylon and China. It is wild in India but appears to be cultivated in the Malaya and Java. It is one of the most important wild tubers with the people of the Deccan and Central Bengal. The root and aerial tubers are eaten as well as the young flowering spikes.

D.E.P., iii., 132. Fiji Yam.

D. pentaphylla, *Linn.; D. triphylla, Roxb.; Fl. Br. Ind.*, vi., 289; *Rec. Bot. Surv. Ind.*, ii., 143; iii., 288: Prain, *Beng. Plants*, ii., 1066; *Nuren-Kelengu*, Rheede, *Hort. Mal.*, vii., tt. 34, 35 The Kawan or Fiji Yam. Met with throughout tropical India on the lower hills from Kumaon to Burma, Ceylon and Malacca. It is an extensive climber, the stem prickly below and sometimes bulbiferous. It affords large edible tubers that are eaten practically all over India, especially with the Kathodis of the Konkan, the Savarahs of Ganjam and the Lepchas of Sikkim. The flowering stems and young leaves are also eaten, especially in times of scarcity. But it is said to afford both poisonous and innocuous forms, the latter being made edible by repeated boiling and washing. It is apparently, however, never cultivated in India, except perhaps in Pondicherry. [*Cf. Circ. Roy. Bot. Gard. Ceylon*, 1905, iii., 16–7; Achart, *Quinze Cents. Pl. dans L'Ind.*, 1905, 206.]

D. spinosa, Roxb.—This plant has been confused with ***D. fasciculata*** and ***D. aculeata***, Linn. It is, in fact, placed by Prain (*l.c.* 1066) as a variety of ***D. fasciculata.*** Its most generally accepted names are *madhválu* in Sanskrit and *mau-álu* in Bengali, but these are also assigned to ***D. aculeata***, Linn., so that it seems probable the two plants are often confused by the people of India as also by most botanists. The tubers are largely eaten in the countries where procurable.

Subsidiary Foods.

Famine Foods.

Yam Area of India.

CULTIVATION.—Of the yams above briefly indicated three species are very generally grown in India as subsidiary foods. These are ***D. alata***, ***D. bulbifera*** and ***D. fasciculata.*** Under each of these species, however, there are several varieties and even a large assortment of cultivated races, so that the yams are not only varied but abundant plants. It is, in fact, only within the very driest tracts (such as some portions of Rajputana, Sind, the Western Panjáb and the Deccan) that yams are not to be found. Wild yams are also very prevalent and constitute an important article of food with the poor, more especially the inhabitants of uncultivated tracts, and in times of famine they often become of the greatest possible value. Lewin (*Wild Races S.E. Ind.*, 1870, 27) says that in the hills of that country wild yams are so plentiful that no man, able to search for food, need starve. Speaking in general terms, a line drawn from Khatmandu and Lucknow to Ahmedabad would sever India into two portions—the Southern (more especially its south-eastern tracts) might be described as the yam-producing area of India, and the Northern (more especially its north-western tracts) the non-yam-producing division. Through Bengal and Assam the yam country extends to Burma, Siam, the Malaya (Peninsula and Archipelago) to China and Japan.

Asiatic Habitat.

History.

In the *Dictionary* a few passages from De Candolle were quoted and the contention advanced that the historic importance of the Indian cultivated yams had been depreciated owing to no work of sufficient merit having recorded their Sanskrit and vernacular names. "Roxburgh," says De Candolle (*l.c.* 77), "enumerates several ***Dioscoreæ*** cultivated in India; but he found none of them wild, and neither he nor Piddington mentions Sanskrit names. This last point argues a recent cultivation or one of originally small extent, in India, arising either from indigenous species as yet undefined, or from foreign species cultivated elsewhere." . . . "The absence of distinct names in each province also argues a recent cultivation." A very extensive assortment of vernacular names for each species has been recorded, however, by Prain and Burkill, and these amplify materially the names given in the *Dictionary*. They thus abundantly substantiate the opinion of India being one of the great centres of original production (if not the chief Asiatic centre) for yams. It seems likely that both the sweet-potato and the ordinary potato, being more tractable, have not only largely supplanted the yams but usurped their classic names and history.

American Habitat.

Asa Gray (*Scient. Papers*, i., 322) says that Columbus when he discovered Cuba and St. Domingo found the Natives cultivating two kinds

African Habitat.

of edible roots. "These were called in the language of the islanders of St. Domingo, *Ages* (*Ajes*) and *Yuca*." The last mentioned is ***Manihot*** and may be dismissed from further consideration, but the former (it is nearly certain) was a species of ***Dioscorea.*** This the Spaniards (being ignorant of the language of these islands) called *name*, *niame*, *inhame*—corruptions, it is supposed, of an African name (with which they were already familiar) for a similar edible tuber. Clusius (*Hist. Exot. Pl.*, 1605, 237–8, reprinting Garcia de Orta, 1563, *Coll.*, xviii., 3) speaks of the African slaves of Portugal eating the tubers of a ***Colocasia*** which they called *inhame*. Hence that name had, at an early date, reached Europe and India. Some of the companions of Columbus had doubtless seen the *inhame* tubers of Africa, and were thus ready to assign that name to the West Indian tuber when their attention was drawn to it. To this circumstance is accordingly due the constant use (by 16th and 17th century writers) of *inhame* (or, as it ultimately became, *ihame* and finally *yam*) as a generic denomination for any and every edible (starch-yielding) tuber.

Sanskrit Name.

There would seem little doubt that the Indian word *álu* (in Sanskrit and Hindi and *ala* in Sinhalese) originally denoted a starch-yielding edible tuber, possibly in its earliest signification the edible species of ***Dioscorea,*** though in later usage it came to mean ***Amorphophallus*** and even ***Colocasia.*** A prefix was employed to denote the separate species. Hence we have in Sanskrit the *dandálu* (elongated *álu*), *madhválu* (sweet *álu*), *pindálu* (round *álu*) and *raktálu* (red-*álu*). In the Sanskritic vernaculars we have similarly *chupriálu*, *guraniya-álu*, *kanta-álu*, *kham-álu*, *mau-álu*, *pindalu*, *ratálu*, and *sasniálu*. But in the aboriginal languages there is a vast assortment of names not only perfectly distinct from each other and in no way traceable to the Sanskrit, but which have either a direct specific or in some cases even a generic signification :—*ato sang*, *bengo-nari*, *bir sang*, *gun*, *genasu*, *kalangu*, *kullu*, *kniss*, *kris*, *myauk*, *piska*, *taguna* and *tar* (or *tarar*). Most of these names (many others might be given) denote knowledge prior to the Aryan conquests of India and thus leave no room for doubt that the cultivation of yams is quite as ancient (if not more so) in India as in any other country. Indeed from the fact that names are given in the West Indies and other tropical countries, traceable to the Sanskrit, or to some Indian vernacular, there would seem no doubt that some of the best-known cultivated forms in other regions were derived originally from India. And what is more curious, not a few of these are being brought back to India to-day as special West Indian plants, oblivious of the fact that, just as with the improved rice brought from Carolina and the superior wool-sheep from Australia, they had been procured in the first instance from India.

Aboriginal Names.

Seeds.

Sets.

Propagation.—The yam may be propagated either by means of aerial tubers or small underground tubers or portions of large tubers. If the former be employed, the first year's crop is poor but the second excellent. It is preferable to use sets of the underground tuber weighing about half a pound. The best soil is a deep friable sandy loam. Stiff heavy soils are unsuited, as the tubers cannot expand properly and good drainage is essential. The selected land should be dug to a considerable depth and fairly well manured. It is then lined, 3 to 4 feet apart, and the seed tubers set on the ridges at distances of 18 inches. Some cultivators prefer to start the seed tubers in a nursery and to transplant to their permanent position when a foot or so in height.

Soil.

Tillage.

Planting.

Staking. Trailing. Wild Stock. Seasons.

Alongside is secured a stake (usually a bamboo) perhaps 8 to 15 feet in height above ground, and it is customary to bind these together at the top in clusters of four. It is also not uncommon to grow special trees on which the climbing stems of the yams may be trained. When this is the case pits are dug alongside of the trees and filled with new soil and manure and the sets deposited within these. Occasionally (as, for example, in Bihar) the plants are allowed to trail on the ground, but the yield is believed to be then smaller. In the West Indies, however, the crop is often treated in this way, and apparently with satisfactory results. It is also affirmed that in China the trailing stems are pegged or layered into the ground, and thus caused to root, the result being that tubers are formed at the new points of growth. With certain species, having a rhizome-like underground stem and one or two large tubers, the lower edible portion is cut off and the upper rhizome planted for next year's growth. This, however, is rather the careful system pursued with wild yams than a regular method of agricultural propagation. Planting is done in April and the crop comes into season about December. This is the usual practice, but a wide range of seasons exists in direct adaptation to local conditions and the species of plant grown. Thus in Arcot it is said the yam is cultivated in January and harvested in August and September. In the Konkan yams are sometimes grown alone and the crop comes into season about October. In Upper India, according to Duthie and Fuller, the tubers of ***D. bulbifera*** are planted in May and June and dug up every three years. Of ***D. alata, var. globosa,*** these authors say it is planted in June and the crop gathered the following February.

Yield. Supplementary Crop.

Yield.—The yield depends largely on the plant grown, the nature of climate and soil, the degree of cultivation, and the proportion of the produce treated as edible. The yield has been variously put at from 3 to 10 tons an acre, or approximately the same as the yield of potatoes. But yams are in India most frequently a supplementary crop to ginger, turmeric, *brinjal*, sweet-potato or maize. Yams are moreover more nutritious than ordinary potatoes, so that the combined produce may be accepted, from the standpoint of food supply, as highly satisfactory.

Chemistry.—Bhaduri (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1902–3, 25) says the acridity of yams is due to the presence of needle-shaped crystals of calcium oxalate, and the poisonous property to the presence of the alkaloidal principle *Dioscoreine* first isolated by Boorsma of Java. Hooper (*l.c.*, 1903–4, 32) gives the results obtained during the examination of some forty kinds of these tubers. The poison was found most abundant in ***D. dæmona,*** but was often present in ***D. bulbifera*** and ***D. pentaphylla.*** "The average amount of moisture in fresh tubers was 80 per cent., and the average percentage composition of the dried tubers was: fat 1·02, albuminoids 10·87, carbohydrates 77·01, fibre 5·16, ash 5·94, and nitrogen 1·73. The starch of the yams was examined microscopically and certain species were found to have characteristically shaped granules, which distinguished them from other species."

[*Cf.* De Candolle, *Orig. Cult. Plants*, 1884, 76–81; Asa Gray, *Scient. Papers*, 1889, i., 322–6; Mollison, *Handbook Ind. Agri.*, 1901, iii., 197–200; Mukerji, *Handbook Ind. Agri.*, 1901, 203, 467, 477; Morris, *West. Ind. Yams, Imp. Dept. Agri.*, 1902, No. 18; Nicholls, *Textbook Trop. Agri.*, 1892, 284–8; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 140–2; *Notes on Dioscoreas Cult. in Roy. Bot. Gard., Ceylon,* in *Circ. and Agri. Journ.*, 1905, iii. 1–9.]

D.E.P., iii., 136-56.
Ebony.

DIOSPYROS, *Linn.*; *Fl. Br. Ind.*, iii., 553-72; Gamble, *Man. Ind. Timbs.*, 453-63; Cooke, *Fl. Pres. Bomb.*, i., 98-107; Prain, *Beng. Plants*, i., 651-4; Brandis, *Ind. Trees*, 428-36; EBENACEÆ. A fairly important genus which embraces about 59 species of Indian forest trees. They occur chiefly in South India, Ceylon, Burma and Eastern Bengal. Only four extend to Northern India, while the genus may be said to be not represented in the Eastern Himalaya. All the species yield useful timbers, of which the best are the various forms of Ebony (***D. Ebenum*** and ***D. melanoxylon***), known in the vernaculars of India as *ebans* or *tendu*. The most important are:—

Ebony.

D. Ebenum, *Koenig.*; *Roxb.*, *Fl. Ind.*, ii., 529; Trimen, *Fl. Ceyl.*, iii., 94. The EBONY, *ebans, abnús, tendu, khenda, temrú, tai, acha, nullútí, shengútan, kakatati, tuki, kare, bale, mushtimbi, karunkáli, mallali, kaluwara*, etc., etc. A large tree not very common in India, where it is found in the Deccan and Karnátak, chiefly in dry evergreen forests in the Ceded Districts. In Ceylon, however, it is one of the chief woods, very common in the dry regions of the Northern Provinces. [*Cf.* Herbert Wright, *The Genus Diospyros in Ceylon, its Morphology, Anatomy and Taxonomy*, 1904.]

Timber.

This species is perhaps the best ebony-yielding tree and the only one which gives a black heart-wood without streaks or markings. Gamble says 74 lb. is the average weight per cubic foot for the heart-wood. In Europe it is extensively used for ornamental turnery, cabinet-work, piano keys, rulers, etc., and in China for chopsticks, pipes, carved stands and vases. Ebony does not appear to be exported from India to any material extent, but in Ceylon the average sales for 1892-1902 were 300 tons yearly. The average price Gamble gives at 180 to 185 Rs. per ton. The *Indian Forester* (1905, xxxi., 37, app.) gives £6 to £10 per ton as the price of East Indian Ebony.

Trade.

Gab.

D. Embryopteris, *Pers.*; Roxb., *Fl. Ind.*, ii., 533; *Rec. Bot. Surv. Ind.*, ii., 30, 115, 240, etc.; iii., 233; Talbot, *List Trees, etc.*, 211; Trimen, *l.c.* 93. The *gáb, makur-kendi, kúsi, timborí, tumbika, pani-chika, karunthali, kavi-kattai, hollet-upra, tumil, tinduki, nitta-tumma, kusharta, hige, bantha, vananchik*, etc., etc. A dense evergreen tree found throughout the greater part of India in shady wet places and near streams. It is frequently cultivated both for ornament and for its large red, velvety fruits.

Gum.

Pulp.

Many writers speak in general terms of a gum obtained from this plant, but do so in such a manner as to suggest a confusion between a true gum and an extract prepared from the fruit, the pulp of which is used in book-binding, and in place of tar for paying the seams of boats. According to some writers the pulp is used direct; others say an extract or decoction is prepared. Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 152) thus describes the process pursued in Bengal:—"It (the fruit) is beaten in a large mortar and the juice expressed. This is boiled, mixed with powdered charcoal and applied once a year to the outside of the planks." Duncan (*Monog. Dyes and Dyeing in Assam*, 1896) observes that the half-ripe fruits are pounded in a mortar and then kept six or seven days in water until they have decomposed. A gummy solution results, which is poured off and the sediment thrown away. The brownish liquid thus obtained is used in dyeing and tanning. It is made into a good black by being combined with myrobalans (***Terminalia Chebula***) and proto-sulphate of iron (*hira-kash*). The infusion is largely employed for tanning fishing nets and lines, and it makes them more durable.

Dye and Tan.

Per-simmon.

Preserve.

D. Kaki, *Linn.*—A small tree met with in the Khasia hills and perhaps also in Upper Burma. It is cultivated here and there over the moister tracts of India as a fruit tree, but is only suited to very large gardens. It is the CHINESE DATE PLUM or PERSIMMON, and in Burma appears to be known as *tay, teh*. The fruit ripens during August and is about the size of a large apple with twin almond-like stones. The rind is of a rich, ruddy colour. It has a rather disagreeable odour, and in flavour is suggestive of an overripe apple. A fine preserve is said to be made from it by the Chinese. [*Cf.* Roxb., *Fl. Ind.*, ii., 528; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 221-2.]

Marble-wood.

D. Kurzii, *Hiern.*—One of the most important trees of the Andamans, termed in English MARBLEWOOD; in Burma *teakah, thitkya*, and in the Andamans *pecha-da*. Gamble remarks that this wood would be of great value in the

European market, were it procurable in sufficient quantity. *The Administration Report, Andaman Islands* (1898–9) speaks of squares up to 12 feet (siding up to 6 inches) being obtainable.

D. Lotus, *Linn.*—A medium-sized tree, met with in the Panjáb Himalaya, Hazara, Kashmir, Baluchistan and Afghanistan. It is the *amlúk, malúk,* etc. It yields a gum said to cause a large quantity of water to solidify to a jelly (*Ann. Rept. Ind. Mus. Calc.*, 1901–2, 24). The ripe fruit is largely eaten either fresh or dried. It is imported by the Kabulis into Peshawar and is often used in the preparation of sherbet. **Amlúk.** Gum. Fruit.

D. melanoxylon, *Roxb.*—A medium-sized tree found, according to Gamble, in South India, in the dry forests of the Maratha country, the Deccan and Karnátak; but Brandis, by regarding it as doubtfully distinct from ***D. tomentosa***, extends its area to the deciduous forests of the Central Provinces, Chota Nagpur, Bihar and the Western Peninsula. It is known in trade as COROMANDEL EBONY and by the following, amongst many other names:—*tendu, kendu, temru, abnus, tumi, kari-mara, damádi, balai,* etc. Speaking of ***D. melanoxylon*** proper, Gamble observes large trees are uncommon and the amount of ebony small; of ***D. tomentosa*** he says that it is the tree which gives the ebony most largely used in North India. From it is made the Nagina (Bijnor district) black carved woodware. For full particulars of that art centre and its utilisation of ebony, consult *Indian Art at Delhi*, 1903 (100, 112–3, 123, 149, etc.). The fruit ripens about December and is edible. During famine it is pounded and made into bread. [*Cf.* Banerjei, *Agri. Cuttack*, 1893, 185–6, 195; Cameron, *For. Trees Mysore and Coorg*, 1894, 178; Hove, *Tours in Gujarat, etc.*, 1787, 145.] **Coromandel Ebony.** Nagina Wood-carving.

D. montana, *Roxb.*—A small tree found throughout India and Burma. It is known as a form of *tendu*, but its distinctive names, among others, are:—*ban-gáb, tembhurni, gara-tiril, lohari, hirek, goindu, makartendi, jagalaganti, ambia, hádru, kachan, muchi tanki, tawbut,* etc. It does not grow to a large size, and the timber, though described as a beautiful furniture wood, is rarely suitable for such purposes. According to Day (*Fishes of India*) the fruits of the *bistendu* or *kuhar* are thrown into the water to kill fish. Kanjilal (*For. Fl. of School Circ. U. Prov.*, 1901, 220–2) says every part of the tree, including the fruit, is bitter and has an unpleasant smell. **Ban-gáb.** Fish Poison.

DIPTEROCARPUS, *Gaertn., f.*; *Fl. Br. Ind.*, i., 295–9; Gamble, *Man. Ind. Timbs.*, 1901, 70–3; Prain, *Beng. Plants*, i., 251–3; Brandis, *Ind. Trees*, 65–6; DIPTEROCARPEÆ. A genus of lofty trees, which embraces some 50 species, natives of tropical East Asia. Of these 17 occur in the Indian area and some 8 or 9 in India proper. On purely economic grounds I propose to treat as species plants that may be only doubtfully distinct botanically, but in doing so I am practically following the lead given by Prain. The various forms are chiefly noted for their oleo-resins and timbers. The unimportant species are:— **D.E.P. iii., pt. i., 157–71.**

D. alatus, *Roxb.*, *Fl. Ind.*, ii., 614. A very large tree, native of the tropical forests of Burma, where it is known as white *kanyin* or *kanyinbyn*. It gives a large quantity of a rather thin wood-oil. Gamble remarks that this is probably considerably mixed with that of *eng*. [*Cf.* Roxb., *Trans. Soc. Arts*, 1806, xxiii., 413.] **D.E.P., iii., 157. Kanyin.**

D. costatus, *Gaertn., f.*; *D. alatus*, *Fl. Br. Ind.*, i., 298. This, like ***D. lævis***, is called *tetia-garjan* in Tippera.

D. Griffithii, *Miq.*—A tall tree of the Mergui and South Andaman Islands. This broad-leaved tree affords one of the qualities of Andaman *gargan*-oil. **D.E.P., iii., 159.**

D. indicus, *Bedd.*; Brandis, *Journ. Linn. Soc.*, xxxi., 26; *D. turbinatus*, *Fl. Br. Ind.*, i., 295 (in part); Talbot, *List Trees, etc.*, 1902, 33; Cooke, *Fl. Pres. Bomb.*, 1901, i., 84. The *guga, challane, ennei, kalpayin, varangu,* etc. A lofty tree of the evergreen forests of the Konkan, Kanara, Malabar and Travancore. The wood-oil tree of Western and Southern India. **Malabar Wood-oil.**

The Conservator of Forests, Coorg, gives an account of the wood-oil prepared in that portion of the west coast of Southern India. He says—"We have two oil trees in the Western Ghat Forests of Coorg. Both, I believe, are species of ***Dipterocarpus***, but have not been able to get the flowers to identify them. The oil is contained in the pores of the wood, and is collected by cutting a hole into the centre of the tree. One species yields a yellow oil and the other a dark red. Two Oils.

The former is sold in the bazars mixed with dammar (the produce of ***Vateria indica***) as varnish at 5 annas a bottle. The latter also makes a fair varnish. It has a strong copaiba-like smell and would probably be useful in medicine." One at least of these oils must be regarded as afforded by the present species, whether it be accepted as distinct from ***D. turbinatus*** or only a variety of it.

D.E.P., iii., 158-9. Telia-garjan.

D. lævis, *Ham., Mem. Wern. Soc.*, 1832, vi., 298-9; *D. turbinatus, Roxb., Fl. Ind.*, ii., 612 (in part); *Fl. Br. Ind.*, i., 295 (in part). Prain speaks of this as a tall tree met with in Tippera, where it is known as *telia-garjan*. He remarks that as so accurate an observer as Buchanan-Hamilton separated his ***lævis*** from ***turbinatus***, on account of their different economic properties, it seems better to leave the two trees as distinct species. In a letter to Roxburgh dated Oct. 16, 1798, Buchanan-Hamilton speaks of four species of "*gurgeon*" found by him in Chittagong, which doubtless included the present species.

D. obtusifolius, *Teysm.*—A large deciduous tree of the *eng* forests of Prome and Martaban. It is the *kanyingok, inbo, in-kohe*.

D.E.P., iii., 159. Hollong.

D. pilosus, *Roxb., Fl. Ind.*, i., 615. A tall evergreen tree of Assam, Chittagong and Burma. It is best known as the *hollong*. Brandis observes that it yields a semi-fluid resin, and it is described by Hooper as white (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1904-5, 24). Gamble speaks of the wood as good but not suited for tea-boxes. Peal refers to it as employed for canoes. This is possibly the tree mentioned by Robinson (*Desc. Acc. Assam*, 1841, 62).

D.E.P., iii., 160-1. Eng.

D. tuberculatus, *Roxb., Fl. Ind.*, ii., 614. The Eng Tree, *eng, in, sooahn*. A large deciduous, gregarious tree forming the "*in* (*eng*) forests" of Burma, Chittagong and Siam. It is said to be very characteristic of laterite soils and to take the place of the *sal* in Northern and Central India.

Wood-oil.

Torches.

Oleo-resin.—It was for some time thought that the *eng* tree did not give a wood-oil, but Mr. J. W. Oliver explained that it yielded a thick oil or rather oleo-resin. The reader will find Mr. Oliver's most interesting report in the *Dictionary* (iii., 160-1). The method of extraction is very similar to that for *garjan*-oil, explained below. The congealed resin which remains behind, after the removal of the oil, is scraped off and used for torches which are made of rotten wood, mixed with the resin and rolled up in the leaves of the *satthwa*, a species of screw-pine. In some localities, however, the rotten wood is soaked in the oil itself and wrapped up in the leaves of a palm-*salu* (***Licuala peltata***). Nisbet (*Burma Under Brit. Rule and Before*, 1901, 365) says that "twenty years ago the chief luminant used after dark through the rural tracts, except those of the dry zone within easy reach of the central petroleum fields, was a small torch about a foot and a half long made of chips of dead wood and the resinous oil of the kanyin or wood-oil tree ***D. turbinatus*** rolled in palm leaves. . . ." "These kanyinsi torches were sold in bundles in every bazar. While burning they emitted incessant smoke and a strong oily smell, pungent and differing vastly from the European idea of fragrance. At one time the manufacture of these torches formed an industry wherever the wood-oil trees abounded; but now, in consequence of improved communications and of large imports of kerosene at low rates, torch-making is only betaken to in jungle tracts in order to eke out the means of livelihood during bad years, when the shadow of misfortune darkens the threshold."

Oil.

Timber.

The oil is used for waterproofing bamboo baskets, etc. With regard to the wood, Gamble (*l.c.* 72) says, "The *Eng* is probably the best of the woods given by the species of ***Dipterocarpus***, and it is in considerable demand and use for building and boats." In point of weight it would seem to average 54 lb. [*Cf.* Brandis, *Ind. For.*, 1875, i., 365; Semler, *Trop. Agrik.*, 1900, ii., 536-7.] Hooper (*Agri. Ledg.*, 1902, No. 1, 15) mentions a tannin extract obtained from the bark of this tree.

D.E.P., iii., 161–71.
Kanyin.

D. turbinatus, *Gaertn., f.;* Buch.-Ham., *Mem. Wern. Soc.*, 1832, vi., 300; Roxb., *Fl. Ind.*, ii., 612 (in part); Ribbentrop, *Forestry in Br. Ind.*, 1900, 10. Kanyin Oil Tree, *garjan*, *dulia garjan*, *kanyoung*, *kanyin*, *kanyin-ni*, *kanyin kohe*, etc. An evergreen tree of Eastern Bengal, Chittagong, Burma, and (according to Gamble) of the Andaman Islands. Distributed to Singapore.

Lofty Trees.
Two Forms.

One of the loftiest of Indian trees, being sometimes 250 feet in height. Hooker (*Himal. Journ.*, ii., 348) in his account of Chittagong says: "This is the most superb tree we met with in the Indian forests: we saw several species, but this is the only common one here; it is conspicuous for its gigantic size, and for the straightness and graceful form of its tall unbranched pale grey trunk and small symmetrical crown: many individuals were upwards of 200 feet high and 15 in girth." In recent official correspondence mention has been made of a broad and narrow-leaved *garjan* oil plant. The latter has been determined to be a special variety of ***D. turbinatus,*** for which the name ***andamanicus*** has been suggested, and the former is ***D. Griffithii*** (see above).

Oil.
Various Grades.

OLEO-RESIN.—With regard to the various species of ***Dipterocarpus*** that yield wood-oil (*garjan*), the following information was obtained some few years ago from the Government of Burma:—"*Kanyin* oil is the produce of ***D. lævis*** (*kanyin-in* = red *kanyin*) and of ***D. alatus*** (*kanyin-byn* = white *kanyin*), which are common in evergreen forests, and probably of other species of similar habitat." It seems likely, however, that the source of the superior quality of oil has changed within recent years owing to the comparative extermination of the plant most noted in former times. It is also highly probable that the plant valued at the present day may be a species but indifferently known to botanists. Every here and there, more than one grade of oil is described by popular writers, whereas in most cases only one species of wood-oil tree is recognised. It is on that account that I have retained for the present the names used in the *Dictionary*, namely, ***D. lævis, D. tuberculatus*** and ***D. turbinatus.***

Garjan.
Season of Collection.
Fire.
Yield.
Tapping Prohibited.

Garjan Oil is in Burma generally collected in the dry weather only—(November to May). In the Andaman Islands it does not flow before January 15, and is finished by April 25. The oil is obtained by cutting two or three deep pyramidal hollows (the apex pointing towards the interior) near the foot of the tree, and by applying fire to the upper cut surfaces. The fluid then collects at the bottom of the hollow, which is emptied every three or four days. Fire is applied after the oil is removed, and the upper surfaces of the hollow are chipped three or four times during the season. In Tharawaddy district, where trees are not very plentiful, it is considered that twenty are about as many as one man can attend to. The yield of twenty trees would be 100 *viss* for the season, worth Rs. 25. In Prome district the oil may be said to come into the market in the form of torches similar to those already discussed under ***D. tuberculatus.*** In the *Forest Administration Reports of the Andaman Islands* (1897–8, 7; 1899–1900, 4, 5; 1901–2, 13; 1903–4, 7) particulars are given of the methods pursued in collecting the oil. In the Chittagong district it is prohibited to tap the trees owing to the large number already killed. This prohibition it is understood does not extend to the hill tracts. A recent official communication, for example, states that the extraction of the oil is not pursued there because it is not remunerative enough.

Industrial Uses.

Resinous Concretion.

Varnish.

Substitute for Copaiba.

Chinese Wood-oil.

Very little is known for certain of the industrial uses of the oil, still less of the resinous concretion as distinct from the liquid oil. The former is fairly extensively employed by the Burmese for torches, and the oil is largely used in preserving bamboo wickerwork and in paying the seams of boats. As a varnish it is believed to protect woodwork from the ravages of insects. In Europe it has been in fact made into a varnish, and is reported to be a useful ingredient in lithographic ink. It was in the *Dictionary* pointed out that an important way of utilising the article might be found in taking advantage of Mr. Laidlay's discovery that it acts as a solvent to caoutchouc. Sir W. O'Shaughnessy remarked fifty years ago that it would likely be found a perfect substitute for the expensive balsam of copaiba. In the *Journal Chemical Society* (1902, xxi., 1404) it is affirmed that "Chinese wood oil" is not suitable to replace linseed oil in the preparation of varnishes. It cannot be heated above 160° C. *Capital* (April 1904) gives useful particulars regarding Chinese wood-oil—a substance which cannot possibly be mistaken for *garjan* (see p. 46).

Specific Variability.

Adulteration

Chemistry.—In the *Dictionary* will be found an abstract of the results obtained by the distinguished authors in the *Pharmacographia*. More recently Hooper has published his examination of the samples procured by the Reporter on Economic Products, from which the following passage may be furnished:—"Eighteen samples of *garjan* balsam from Bombay, Madras, Tippera, Chittagong, Assam and Burma had been submitted to analysis. The specific gravity ranged from 0·957 to 0·999, the percentage of volatile oil from 36·9 to 71·1, and the acid number from 3·12 in a Chittagong sample to 21·9 in one from Rangoon. These oils, procured from ***D. turbinatus***, ***D. lævis***, etc., were very irregular in composition and physical contents, and would lead one to believe that adulteration is practised in certain quarters. The balsam secreted by ***D. tuberculatus*** and known in the trade as 'Jusi' is more uniform in composition. It has a thick honey-like consistence with a high sp. gr. and acid value, but a low proportion of volatile oil. Samples of the oleo-resin of ***D. Griffithii*** and ***D. turbinatus***, *var.* ***andamanicus***, collected from botanically authentic sources from the Andamans, were of exceptionally good quality. The chemical examination of a series of balsams of this character enables one to recognise their peculiar reactions, so that it is easy to detect substitutions and adulterations. During the course of the inquiry a sample of oleo-resin from South India, although labelled ***Dipterocarpus***, was found to be the product of the '*yen nemaram*' (***Hardwickia pinnata***). . . . To thoroughly understand the differences of composition of gums, resins, and oleo-resins, samples should be collected from the trees and the conditions of age, climate, soil, etc., studied on the spot." [*Cf.* Wiesner, *Die Rohst. des Pflanzenr.*, 1900, i., 236–7; Tschirch and Weil, *Acc. Gurjun Balsam*, in *Proc. American Pharmaceut. Assoc.*, 1904, lii., 700-1; *Pharm. Journ.*, 1905, lxxiv., 722; Tschirch, *Die Harze und die Harzbehälter*, 1906, i., 489–512; Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1906–7, 8; *Pharm. Journ.*, 1907, lxxviii., 4.]

Medicine.

Medicine.—This substance is not very largely used in Indian medicine, and does not appear to have been known to the early authors. It is apparently alluded to in the *Makhzan*, but it is not mentioned by Dutt in his *Materia Medica of the Hindus*. The most recent opinions on the subject only need be here quoted. Dr. Dougall and subsequently Moodeen Sheriff (*Mat. Med. Mad.*, 1891, 49–50) drew attention to the properties of the oil. The latter says, "The best medical properties of this oil are its usefulness in gonorrhea and gleet, and in all forms of psoriasis, including lepra vulgaris." Again: "With regard to its usefulness in psoriasis and lepra vulgaris, I am not aware of any other local stimulant which is more efficacious in those diseases than this drug." But in the *Pharmacographia Indica* (i., 192) mention is made of the investigations conducted by the Government of India, and it is then added that "as far as we have heard the new treatment has not been a success." [*Cf.* Dymock, *Mat.*

Med. W. Ind., 1885, 88–9; Waring, *Baz. Med. Ind.*, 1897, 70–2; Ponder and Hooper, *Mat. Med. Ind.*, 1901, 32.]

Timber

Gamble (*l.c.* 71) remarks that the WOOD of the *garjan* tree is used in house-building and for dug-out canoes, as also for packing-cases, but that it is soon destroyed by white ants. Its large size, however, makes it valuable for temporary purposes; logs 40 to 60 feet in length are sometimes procurable. With regard to weight he tells us that the specimens he had examined averaged 50 lb. per cubic foot. [*Cf. For. Admin. Rept. Burma*, 1899–1900, 18; *Working Plans Rept. Pyinmana*, 1904, 16–7.]

Commercial Importance.

Objections to Trade.

Demand Insufficient.

Centres of Production.

Trade.—Milburn (*Or. Comm.*, 1813, ii., 315) mentions wood-oil, and explains the uses it is put to. Royle, writing in 1840 (*Prod. Res. Ind.*, 77), speaks of wood-oil, but says it has never become an article of commerce. Flückiger and Hanbury (*Pharmacog.*) state that the world's supply is obtained from "Singapore, Moulmein, Akyab, and the Malayan Peninsula and that it is a common article of trade in Siam." Dymock (*l.c.* 91) remarks—"Garjan Balsam is not an article of commerce in Bombay; small quantities may be sometimes obtained in the Native drug shops. The Government supplies have been obtained from the Andaman Islands." Moodeen Sheriff (*l.c.* 49) writes that in Madras wood-oil is common in most large bazárs; he describes several forms and gives their prices. A firm of Calcutta merchants, in a letter dated October 25, 1900, undertook to supply *garjan* oil in 40-gallon casks at Rs. 47 per cwt. delivered in Calcutta. An official correspondence in 1901 resulted in the discovery that some objection existed in the minds of European merchants in Rangoon to engage in the traffic in *kanyin* (*gargan*) oil. One firm reported that the quality of the oil varies very much, and the price accordingly. The quotation given by them at that time was Rs. 60 per 100 *viss*—equal to about Rs. 20 or £1 6*s.* 8*d.* per cwt., but this does not include casks or drums. The Conservator of Forests in a communication of same date was of opinion that if an assured demand arose, there would be little difficulty in procuring local persons willing to supply the oil in Pyinmana Division, the Ruby Mines Division and Tenasserim Circle. It will thus be seen that very little of a satisfactory nature can be furnished regarding the Indian supply of this article. There are four chief centres of production—Burma, Andaman Islands, West and South India and Chittagong. The last mentioned, though formerly perhaps the most important, is the least valuable at the present day, and therefore it may be said that the supply, such as it is, comes almost exclusively from Burma and the Andaman Islands and is exported from the port town of Rangoon chiefly. The returns in one province appear as lb., in another as *viss*, in a third as gallons, so that a combined statement is impossible. Moreover, in official statistics it is sometimes grouped with "resin," at others with minor forest produce. One point only seems indicated, namely that with the growth of the Chinese wood-oil (**Aleurites Fordii**, p. 46) a decline in both the supply and demand of *garjan* has taken place.

DOLICHOS, *Linn.*; LEGUMINOSÆ. A genus of twining herbs of which there are 20 species, six natives of India and two of economic value:—

D.E.P., iii., 175–83. Horse-gram.

D. biflorus, *Linn.*; *Fl. Br. Ind.*, ii., 210; Buch.-Ham., *Journ. Mysore, etc.*, 1807, i., 107–8, 286, 377; ii., 105, 198–9, 220, 323; iii., 240, 296–7, 326, 352, etc.; Roxb., *Fl. Ind.*, iii., 313; Prain, *Beng. Plants*, i., 391 ; Duthie, *Fl. Upper Gang. Plain*, i., 229 ; Cooke, *Fl. Pres. Bomb.*, i., 382. Horse-gram, *kúlthí*, *kurthi-kalai* or *kurthi* or *kurti*, *kalath*, *khulti*, *kolatha*, *kulat*, *gahat*, *horec*, *barát*, *roíong*, *gágli*, *botang*, *wulawalli*, *ulava*, *hurali*, *hulga*, *hulle*, *papadi*, *múthera*, *simbi*, *beji máh*, *khárek*, *pé-ngapi*, etc. ; *guár*, sometimes given to this plant, more correctly denotes ***Cyamopsis psoralioides.***

Two Main Forms.

Varieties and Races.—According to Baker (*Fl. Br. Ind.*, *l.c.*) there are two forms of this plant, ***D. uniflorus***, a sub-erect annual, and ***D. biflorus***, a more or less twining plant. The habitats of these forms are not separately recorded. He apparently treats of both when he says it occurs on the "Himalayas to Ceylon, and Burma, ascending to 3,000 feet in Sikkim, sometimes cultivated. Distributed everywhere in the tropics of the Old World." The writer, however, is of opinion that a mistake may have been made in linking the Himalayan with the plains plant. Roxburgh refers to two forms, one with grey, the other with black seeds, both of which he implies are cultivated in Bengal and Madras. The grey-seeded plant, ***D. biflorus***, is erect, has twining branches, and is about 2 to 3 feet high. Roxburgh then adds—"I have never found it *but in a cultivated state*." As already observed, there would appear to be room for doubt as to whether the grey and the black-seeded forms of Roxburgh are the two forms of modern writers, or whether both of Roxburgh's plants constitute but cultivated races of one of these forms. In popular works on economic products the horse-gram of Madras is viewed as ***D. uniflorus***, and under either of these names (***D. uniflorus*** or ***D. biflorus***) a pulse is described as grown in almost every district of India, but chiefly in Madras and Bombay. It is a little difficult to believe that the plant of the tropical plains is the same as that of the temperate Himalaya, but of course this is by no means impossible. Duthie, however, says that as grown on the Himalaya it is more robust, the pods larger and broader, and the seeds grey. Mollison (*Handbook Ind. Agri.*, 1901, iii., 82-4) speaks of two varieties: one, grown sparingly in the Ahmednagar and Kaira districts, has creamy white seeds; the other, commonly cultivated, has grey variegated seeds. But that this cultivated pulse should be regarded as a native of India is abundantly confirmed by the existence of a Sanskrit name—*kulattha*—from which no doubt many of the above vernaculars (*kulthi*, etc) have been derived.

Sanskrit Name.

Green Manure.

CULTIVATION.—Of the plains it may be said that this pulse is grown either as a green manure or as a cattle food and fodder. Mr. Robertson (*Saidapet Farm Repts.*) deals with the advantages of using it as a green manure. Since then, however, the subject of the influence of leguminous crops on the soil has undergone a complete revolution.

Fixation of Nitrogen.

Their chief value, it is now believed, lies in their power to fix the nitrogen in the soil through the agency of the organisms contained in their root warts. Few Indian crops are perhaps more valuable in this respect than the horse-gram, especially when grown as a fodder plant, or still more so as a green manure.

Fodder.

The advantages of growing the crop as a source of fodder are extolled by various writers. Robertson, for example, says that it produces from 2,000 to 4,000 pounds of fodder in two months, at a cost of about Rs. 3 per ton, and thrives with a minimum rainfall in very hot weather. The ease with which it may be cultivated recommends it most highly as a

Catch Crop.

catch crop for forage purposes, either to be grazed on the land or fed in the stalls. The plant may be made to grow at almost any season of the year. It requires but one shower of rain to start its growth, but even if this be not obtained, the seeds have the power of remaining alive for months in the soil and of germinating when rain does fall.

May follow *Rabi* Crop.

After the removal of the *rabi* crop it is contended that a highly advantageous course is to rapidly dress the soil, sow horse-gram, and in a month's time commence to use the stems and leaves as fodder. By this means the soil is saved from becoming baked with the advancing heat of summer, and the roots left in the soil greatly improve it, even should the cultivator be unable to devote the entire crop as a green manure. The following brief account, province by province, may be found instructive :—

Bengal and Assam. Seasons. Seed. Yield.

Bengal and Assam.—Horse-gram is very little cultivated in the Lower Provinces. It is said to be grown to a limited extent in Shahabad, and fairly abundantly in Chota Nagpur, both as a grain and a fodder crop, but not in Lower Bengal. Mukerji (*Handbook Ind. Agri.*, 1901, 263) observes that the time for sowing *kulthi* for grain is October or November, and for fodder June, August and November, three times on the same field. It may be reaped during several months, according to the purpose for which required, but the general harvest is December–January. The quantity harvested per acre Mukerji gives as 300 lb. of grain, or 5 tons of green fodder per crop. Banerjei (*Agri. Cuttack*, 1893, 80–1) discusses its merits as a *rabi*, while Basu (*Agri. Lohardaga*, 1890, 34) calls it a *kharif* crop. Speaking of Assam in a subsequent report (*Agri. Ledg.*, 1903, No. 5, 135), he says that *kulthi-máh* is grown to a small extent in Kamrup and Darrang. In the Tezpur Sub-division it is cultivated by Nepalese and coolie settlers, and in Upper Assam and Nowgong is unknown. Only one variety is grown. The method of cultivation and time of sowing and reaping are very much as with *máti-máh.* About 5 seers of seed are sown per acre ; thin seeding is desirable, the object being to allow the plants to creep and spread over the ground. A good crop may yield up to 6 maunds of pulse per acre.

Upper India. Seasons.

Upper India.—Duthie and Fuller (*Field and Garden Crops*, pt. iii., 2, t. lxxxi.) say that in the United Provinces ***D. biflorus*** is grown mostly as a rainy-season hill crop, ascending the hills to 7,000 feet. Atkinson (*Himál. Dist.*, 343, 460, 696) and Stewart (*Pb. Plants*, 1869, 68) make very similar statements. According to Sir J. B. Fuller, ***Dolichos biflorus*** is grown in the southern districts of the Central Provinces as a cold-weather crop, but is of importance only in the Chanda, Bhandara and Balaghat districts.

Bombay. Area. Seasons. Mixed Crop.

Bombay.—Mollison (*Textbook Ind. Agri.*, 1901, iii., 83) observes that *kulthi* takes the third place among the pulses of the Presidency, and according to statistical returns occupies over 500,000 acres annually. The *Agricultural Statistics* give an average for the five years of over 2,700,000 acres under "other food grains including pulses." Briefly stated, it may be observed that Gujarat and the Konkan are unimportant sources of supply, but that the Deccan and the Karnátak are fairly important (especially the districts of Ahmednagar, Satara, Poona, Dharwar, Belgaum and Bijapur). The principal cultivation is in the *kharif* season as a row or mixed crop, subordinate to *bájri*, hemp (*ambadi*) and niger seed ; only rarely is it a pure crop. Occasionally, however, it is grown in the *rabi* season as a second crop in rice fields. It is very sparingly cultivated in Bombay as a green manure. Of the Deccan, Mollison says *kulthi* participates in the general cultivation given for *bájri* (***Pennisetum typhoideum***). The fields in which it is grown are rarely manured oftener than once in three years. The land is usually prepared by working a heavy-bladed harrow (*rakhar*) two or three times in the hot weather, and again two or three times after rain in June. As a mixed crop it is sown in July, and may occupy every fourth row. The crop is generally bullock-hoed twice a year. If sown in July, the crop will be ripe at the end of October or early in November.

Madras.

Madras.—The crop is very important in this Presidency. Nicholson

Sowing.
Catch Crop.
Seasons.
Area.
Soil.
Varying Practices.
Area.

(*Man. Coimbatore*) tells us that it grows on the poorest soils, and with the minimum of rainfall. Horse-gram land is seldom manured, otherwise than by casual droppings of cattle: it is usually ploughed, sown, and the seed covered by a second ploughing; or the seed is simply scattered broadcast over the natural surface and then ploughed in. As it requires only one good rain after appearing above ground, it frequently gives a fair crop when nothing else can live. When the south-west monsoon rains are too late for *kámbu* (*bájra*) it is frequently sown as a substitute in September, but it is also sown largely in November after the first burst of the north-east monsoons. It is pulled up by the roots, thrown into heaps, and then trodden out by cattle. The yield is up to 1,200 lb. Nicholson (*l.c.*, 1898, ii., 176) gives 194,777 acres as the average under ***D. biflorus*** for the years 1888–93. Mr. H. Goodrich, Collector of Bellary, says a mixed soil is best suited for the crop. The fields should be ploughed and harrowed once or twice, but not irrigated nor (generally) manured. Several other Madras writers, however, give very different accounts of the requirements of this plant, so that the practice seems to vary considerably within the Presidency. In the *Survey Settlement Report of South Arcot*, for example, it is said: "The land is ploughed four or five different times after the month of May, and the gram sown between the latter part of August and the end of September. It is gathered in the middle of March." So again, Moore (*Man. Trichinopoly*, 72) speaks of it as a precarious crop. In the North Arcot District, Cox (*Man. North Arcot*, 1894, ii., 184) gives 48,897 acres as the average under ***D. biflorus*** for the years 1887–93. Unfortunately, while several writers mention figures of area for the districts with which they are familiar, no definite statement of the Presidency as a whole can be furnished, for the reason that horse-gram does not appear to be separately returned. The official figures under "gram" for Madras come to an average (for the five years 1900–5) of almost 150,000 acres. But under "other food grains including pulses" 7,092,389 acres are shown as the area in 1902–3, though it has since contracted to 5,753,913 in 1904–5. It is thus fairly certain that "horse-gram" must be included under the latter, and that the former denotes Bengal gram (the true gram) grown in the Madras Presidency. As indicative of the possible regions of greatest cultivation of this pulse, it may be here added that Bellary had in 1902–3 (when the largest area for the period 1900–5 was returned), 822,685; Anantapur, 771,267; Karnul, 708,877; Kistna, 554,757; and Salem, 590,619 acres devoted to the combined food crops mentioned above.

Mysore.
Mixed Crop.
Germinated Seed.

Mysore.—Rice (*Mysore Gaz.*, 1897, i., 119–20) says the horse-gram is of two kinds, black and white, sown intermixed. In the east the worst qualities of soil are generally used, and on the same fields *sáme* (***Panicum Crus-galli***, *var.* ***frumentaceum***), *háraka* (?***Curcuma longa***), and *huchchellu* (***Guizotia abyssynica***) are cultivated, without one crop injuring the other, or a rotation being even considered beneficial. For horse-gram plough twice, in the course of a few days, any time in October-November. Then, after a shower, sow broadcast; or, if rain does not fall, steep the seed for three hours in water and plough into the soil. It requires no manure, and in three months is ripe for harvest.

Food.

FOOD AND FODDER.—The interest in this pulse is mainly as an article of cattle food, the green stems and leaves being a valued fodder, Cheapest Pulse.

Flour.

Parched Grain.

when grown for that purpose. Although not deemed a superior pulse it is largely used by the poorer classes, being perhaps the cheapest of pulses. The pea is generally soaked for twelve hours, then husked, thus reducing it to the form of *dál* or split-peas. The husk obtained is regarded as a valuable cattle food. The split peas may be reduced to meal, or boiled, or fried and eaten with rice or other articles of diet. The flour is fairly extensively employed in the preparation of sweetmeats. In some parts of the country the grain is dry roasted (parched), then sold to the consumers, who boil it in the preparation of *dál.*

Cattle Food.

Evil Reputation.

The pea is boiled entire and given when cold as an article of cattle food. It is one of the chief pulses so used in Madras and Bombay. Some years ago Robertson performed a series of experiments to test the merits of boiled as compared with steeped horse-gram both on draught cattle and horses. The verdict was in favour of the steeped grain. [*Cf. Rept. Agri. Dept. and Exp. Farms Mad.*, 1871, 4–7.] It is most important that in any attempts that may be made to extend this use to other parts of the world, the distinction should be clearly observed between the horse-gram of Madras (the article here dealt with) and the far superior pea known as Bengal gram (**Cicer arietinum,** pp. 295–302)—the true gram of India. It is also extremely important that both these and all the other peas and beans of India should be recognised as distinct from the *khesárí* (**Lathyrus sativus,** p. 703)—a pulse with an evil reputation that has on more than one occasion injured the prospects of a foreign demand for Indian pulses.

Bhusa.

The fodder is either a by-product of the cultivation of the pea (*bhusa*) or it is a special crop grown and reaped at successive intervals, the plants not being allowed to form fruit. For fodder purposes it may even be sown on the same land two or three times within one year, and the soil is thereby improved rather than injured, as the pulse both cleans it of weeds and adds largely to its nitrogenous property.

Nutrient Ratio.

Medicine.

Oil.

Chemistry.—With regard to the chemistry of horse-gram, Church (*Food-Grains of Ind.*, 162) gives the following analysis. In 100 parts, unhusked:—water 11·0; albuminoids, 22·5; starch, 56·0; oil, 1·9; fibre, 5·4; ash, 3·2. The nutrient ratio is 1 : 2·7, and the nutrient co-efficient 83. [*Cf.* Leather, *Agri. Ledg.*, 1901, No. 10, 360.] The seeds are used medicinally in the Panjáb. Arjun (*Bomb. Drugs*, 40) says a decoction of ***D. uniflorus*** is employed by the Natives in certain diseases of women. [*Cf.* Kanny Lall Dey, *Indig. Drugs*, 1896, 118.] The seeds are moreover reputed to yield an oil.

Area.

Area.—As already explained, the official statistics under which this pulse should be recorded are referred to two sections:—"Gram" and "Other food-grains including pulses." It seems likely that the former denotes ***Cicer arietinum*** and that the latter includes the horse-gram. In 1905–6 the total area in British India under gram came to 11,024,170 acres, and the others to 28,022,722 acres. The available information regarding the production of gram will be found under **Cicer.** It need only be added that of the area devoted to the "others," a fair proportion, especially in Madras and Bombay, would be the present pulse. The following may be given as an analysis, province by province, of the areas under "others":—6,284,192 acres were in Madras; 4,451,000 in Bengal; 4,248,816 in Agra; 2,417,785 in Oudh; 4,743,321 in the Central Provinces; and 2,575,116 in Bombay. These returns give, therefore, the only possible relative indication as to the production of horse-gram, but in Bombay the actual area was 545,738 acres.

D.E.P., iii., 183-90. Lablab.

D. Lablab, *Linn; Fl. Br. Ind.*, ii., 209; Roxb., *Fl. Ind.*, iii., 305; Prain, *Journ. As. Soc. Beng.*, lxvi., pt. ii., 54, 429–30; Prain, *Beng. Plants*, i., 390–1; Duthie, *Fl. Upper Gang. Plain*, 228–9; Cooke, *Fl. Pres. Bomb.*, i., 381. The *sím, makhan-sim, sem, popat, borboti, gheea-sim, panch-sim, lablab, urohi, uri, kechu, chími, katjang, pávta, wall, vál, pauti, válpapri, mochai, bili manavare, mutcheh, alsanda, annapa, avare, pe-bya, pe-bazon, pe-gyi, pe-lun*, etc.

Cultivated Forms.—Wild and cultivated throughout India; it ascends the Himalaya to 6,000 or 7,000 feet in altitude. De Candolle (*Orig. Cult. Plants*, 346) says its culture dates perhaps from three thousand years, but that he can find no trace of its being early diffused in China, Western Asia or Egypt. Hosie (*Rept. Prov. Ssu'ch'uan, China*, 1904, 11) says it is called *ssu chi tou* (four-seasons bean) because it is cultivated throughout the year. Henry (*Econ. Bot. China*, 12) remarks that its Chinese name is *pien-tou*, and that there are two varieties, one with purple, the other with white flowers. So also in India there are two cultivated varieties, though these have not been distinguished in the *Flora British India*. Prain defines them as follows:—

Two Forms.

Var. Lablab proper; pods longer, more tapering at point, seeds with long axis parallel to the sutures. This is *D. Lablab, Linn., Sp. Pl.*, 1019; *D. lignosus, Roxb., Fl. Ind.*, iii., 305 (*non Linn.*).

Var. lignosus (*Linn. sp., non Roxb.*); pods shorter, more abruptly truncated at end, seeds with long axis at right angles to the sutures. Roxburgh, it will thus be observed, reversed the incidence of the Linnæan names.

Prain (*Journ. As. Soc., l.c.* 430) remarks that the epithet "*lignosus*" is much more appropriate when applied to "*Lablab*" than when given to the plant to which Linnæus assigned it. "Roxburgh identifies with his '*Lablab*' the plant figured by Rumphius (*Herb. Amb.*, v., t. 136), in an identification that is obviously just; Linnæus gives this very figure as one of the types of his ***D. lignosus***."

History.—Adams (Comment. in *Paulus Ægineta*, 1847, iii., 470) observes that Serapion, on the authority of Aben Mesuai, describes the properties of a climbing plant which he calls *lebleb*. Adams accordingly adds that there is every reason to suppose the *lebleb* of Serapion and Avicenna was ***Dolichos***. De Candolle (*l.c.* 317) gives, on the other hand, an account of the origin of the word *lubia*. He remarks that it possibly comes from the Greek *lobos*, which means any projection, like the lobe of the ear, a fruit of the nature of a pod, etc. Asa Gray (*Scient. Papers*, i., 353), reviewing De Candolle, comments that "the name (*lubia*) seems to be clearly referable to the Greek. It has not been traced earlier than to Jahia Ebn Serapion—an Arabian physician of the 9th or 10th century—whose work '*De Simplicibus*,' compiled chiefly from Dioscorides and Galen, was translated into Latin in the 15th century." The word "*lobíyá* (king of beans)" occurs among the list of autumn (*kharíf*) crops known to Akbar, and lexicographers would seem to regard the word *lubia* as of Persian origin. At the present day, in Upper India, it would appear to be applied to two plants, ***Vigna*** and ***Dolichos***. Considering the time these plants come into season, it seems probable that the *lobíyá* of the *Ain-i-Akbari* (Blochmann, transl., 63) was ***Vigna Catjang*** (p. 1107). I accordingly restrict the word *lobíyá* to that plant; and, if this be correct, it is probable that none of the species of ***Dolichos***, were known to the Persian writers of classic times. Moreover, no species of ***Dolichos*** would seem to have the properties attributed to the *lebleb* of the Arab writers. This reasoning would accordingly assign to the species of ***Dolichos*** an indian origin, an opinion confirmed by the fact that both ***D. biflorus*** and ***D. Lablab*** are met with as wild species, the cultivated races of which bear many purely indigenous names. In the *Taleef Shereef* (*l.c.* 147) "*Lobeia*" is mentioned as a common culinary grain.

Wild in India.

Bengal.

CULTIVATION.*—*Bengal and Assam.—*Lablab* is not a regular agricultural crop in any part of India. It is more correctly speaking a garden plant, and is trained to form arbours over the doorways of village huts. For example, the Director of Land Records and Agriculture says that different varieties are cultivated all over Bengal as garden vegetables. The Rev. Dr. A. Campbell tells us of Chota Nagpur that it is largely cultivated but that he never found it wild. Basu (*Agri. Lohardaga*, 79) remarks that it is sown in July to August. It is allowed to climb on trees or hedges, and the green pods are procurable in January to March. Mukerji (*Handbook Ind. Agri.*, 1901, 263) writes that the time for sowing is July (the quantity of seed per acre being 5 to 8 lb.) and that the time of harvesting is January and February, the yield being 250 to 400 lb. per acre. Seasons. Banerjei (*Agri. Cuttack*, 1893, 118–9) observes that it is planted in specially prepared holes or pits about the middle of June. The plants flower in November–December and the crop is obtained in February–March. Speaking of Assam, it is met with not only in the valley proper but also in the Naga, Garo, Khasia hills and Manipur—each locality having distinctive indigenous names for it. About 45 seers of pods are obtained from each plant in the year, and the average price is six pice a seer.

Upper India.

United Provinces.—Duthie and Fuller (*Field and Garden Crops*, pt. ii., 23) observe that in these provinces this pulse is commonly grown along the borders of tall crops and allowed to twine itself on the plants standing on the margin. Castor-oil is a favourite support. It is never grown as a field crop by itself, as it requires artificial support. Duthie (*Fl. Upper Gang. Plain*, 229) remarks that it is extensively cultivated for its pods, which are harvested in the cold season.

Two Forms.

Central Provinces and Berar.—It is often met with as a field crop in these provinces. Two forms are seen, one with white, the other with dark purple flowers. They are usually grown in lines through the fields, special supports being furnished, or they are left to crawl and to take such support as they can from the stubble of the associated crop.

Bombay.

Several Forms.

Bombay.—There are several very distinct varieties or races of this pulse met with in Western India. These might be grouped into garden and field varieties. The former (as with the other provinces) can be spoken of as late *kharif* plants, since they come into season about December to January. Mollison (*Textbook Ind. Agri.*, 1901, iii., 80) furnishes an interesting account of this Bombay crop. Garden Crop. He says that the form known as *surti pápdi* is grown extensively in gardens in the Surat district. The beans are plucked early and eaten like French beans. Field Crop. The field variety of Surat is a second crop, bitter to taste and called *kadva vál*, but in Southern Gujarat there is still another field form that has smaller pods and is drilled with rice and *tuver* (*Cajanus indicus*) during June–July. The principal crop is the *rabi*, which usually follows rice. It is sown alone or with castor-oil (the dwarf variety). Associated Crops. *Vál* is also grown among other pulses subordinate to *juar* or *bájri*. When the *juar* is reaped, a long stubble, 3 to 4 feet high, is left. This, with the vigorously growing castor-oil and *tuver*, affords support to the climbing *vál*, and heavy successive crops of green beans may be plucked from November to March. Soils. The most suitable soil for *rabi vál* is a heavy black clay retentive of moisture. When the leaves turn yellow and begin to drop off, the crop of ripe beans may be gathered. Yield of Beans. Mollison adds that on good soil and with careful cultivation 1,300 lb. of pulse and an equal weight of useful fodder per acre may be obtained, off the same field from which a crop of rice has been previously harvested. And this is supplementary to the supply of green pods that may have been collected as a fresh vegetable in the early months of growth. The Department of Land Records and Agriculture, Bombay Presidency, in their *Season and Crop Report* for 1903–4, gave 94,993 acres as the total area under this crop; and for 1905–6, 52,969 acres, with, in addition, 232 acres in Sind. The chief localities are usually—in Gujarat, Surat; in the Deccan, Poona; in the Karnátak, Belgaum and Bijapur; in the Konkan, Thána and Kolába.

Madras.
Garden Crop.

Madras and Mysore.—Very little can be said regarding this crop in South India except that it is grown in gardens, being sown from June to August, and reaped from October to March. In the *Dictionary* will be found a selection of passages from the *Madras District Manuals*, and these may be consulted. Rice (*Mysore Gaz.*, 1897, i., 112) says it is always cultivated with *rágí* (***Eleusine coracana***). When the plant is cut it is exposed for one day to the sun and then beaten with a stick to separate the seed. [*Cf.* Buchanan-Hamilton, *Journ. Mysore, etc.*, i., 103; ii., 220, 290, 314, 323, 384.]

Mysore.

Burma.

Burma.—Mason (*Burma and Its People*, 1860, 466, 768) says "the Burmese and Karens grow several varieties of one or two species of *Lablab*, which occupy the place of kidney beans in Europe."

Food.
Substitute for French Beans.
Nutrient Value
Poison.

FOOD AND FODDER.—It is difficult, if not impossible, to estimate the actual area under a garden crop such as the present. It is grown all over India more or less, but is comparatively rare in Northern India, becomes abundant in Central, Western and Southern India, and is extended through Bengal and Assam to Burma. As already indicated, it is grown as a green vegetable (corresponding very largely with French beans and as a ripe pulse with the broad bean) and also as a fodder crop. The ripe pulse is eaten by certain classes only or is employed as a cattle food. Church (*Food-Grains of India*, 1886, 161, t. 31) gives the following, deduced from the chemical analyses of the ripe bean:—Nutrient ratio 1 : 2·5, nutrient value 80. The percentage of albuminoids is rather variable. Leather, in an article on Cyanogenesis in Plants (*Agri. Journ. Ind.*, 1906, i., pt. iii., 224), states that he has obtained prussic acid from the seeds of *vál* by simply allowing the crushed seeds to remain a few hours in cold water. [*Cf.* Leather, *Agri. Ledg.*, 1901, No. 10, 361; 1903, No. 7, 152, 155, 166.]

D.E.P.,
iii., 198.
Durian.

DURIO ZIBETHINUS, *DC.*: *Fl. Br. Ind.*, i., 351; Gamble, *Man. Ind. Timbs.*, 1902, 92; Brandis, *Ind. Trees*, 78. MALVACEÆ. The Durian, *duren*, *duyin*. A large tree native of the Malay Peninsula, though wild and cultivated in Tenasserim.

The earliest European mention of this fruit appears to be that of Nicolo Conti (*Ind. in the 15th Century* (ed. Hakl. Soc., Major, transl.), 9), and the first botanical drawing of it would seem to be that given by Jacobus Bontius, 1629 (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 118), though a crude representation of the tree and its fruit was given by Acosta (*Tract. de las Drogas*, 1578, 231). Garcia de Orta (1563, *Coll.*, xx.) very correctly describes the fruit as agreeable to some, repulsive to others. Linschoten (*Voy. E. Ind.* (ed. Hakl. Soc.), 1598, ii., 51–3, 68) remarks that no fruit in the world is to be compared with it, and Pyrard (*Voy. E. Ind.* (ed. Hakl. Soc.), 1601, ii., 366) affirms that the Indians "esteem this fruit to be one of the best and daintiest in the Indies." A similar opinion is given by Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.*, 1639, 149), while Herbert (*Travels Ind.*, 1677, 334) mentions it among the fruits of Mangalore.

In size it is 10 inches by 7, has a cream-coloured fleshy aril or pulp enveloping the seeds. The smell is most offensive, but the fruit is highly prized, even by Europeans, when the prejudice against it is once overcome. [*Cf.* Wallace, *Malay Arch.*, 57.] The plant thrives well in Burma, where it is cultivated both in gardens in or near the villages and on the hillsides. The garden cultivation is largely in the hands of the Chinese, but the fruit produced is inferior to that from the hills. It sometimes sells in Moulmein at Rs. 20–30 per 1,000. [*Cf. Rept. Settl.*

Operations, Amherst Dist., 1893, 46–7.] It is very successfully grown in Ceylon, and attempts made to cultivate it near Calcutta, on the Nilgiris and at Madras, met with little or no success. Herbert's reference to it in connection with Malabar may perhaps indicate an early traffic in the fruit along the western coast of India, a circumstance that might account for its being described by Garcia de Orta and other early European explorers. [*Cf. Tavernier, Travels* (ed. Ball), 1676, ii., 287; Boym, *Fl. Sin.*, 1656, O (drawing after Acosta); Alexander Hamilton, *New Acc. E. Ind.*, 1727, ii. 81; Crawfurd, *Journ. to Ava*, 1834, ii., 219; Collingwood, *Rambles, etc.*, 1868, 271; Max and Bertha Ferrars, *Burma*, 1900, 87.]

E

ELÆOCARPUS GANITRUS, *Roxb.*; *Fl. Br. Ind.*, i., 400; Gamble, *Man. Ind. Timbs.*, 113; TILIACEÆ. Utrasum Bead Tree, *rudrák, rudrákya, rudra-challu, rudráksha.* A large tree found throughout various parts of India. **D.E.P., iii., 205. Rudrák.**

The hard tubercled nuts are cleaned, polished or even stained, then made into the rosaries and bracelets worn by Brahmins and Sinyásis, and sold at such places as Benares, Allahabad and Hardwar. An effort has recently been made to organise a European trade in buttons and hatpins, etc., made of these nuts. In a letter from the Deputy Conservator of Forests, Lakhimpur, Assam, to the Reporter on Economic Products in 1900, the price for a maund of nuts in Dibrugarh was said to be Rs. 10, and Rs. 12-8-0 landed in Calcutta. Cooke (*Fl. Pres. Bomb.*, 1901, 152) remarks that the stones are imported from Singapore, where the tree is abundant. Sacred Beads. Price.

E. serratus, *Linn.*; *Fl. Br. Ind.*, i., 401; *jalpai, perinkara, meralu, uttraccham*, etc. A rather small tree, occurring on the North-East Himalaya up to 3,000 feet in East Bengal, and in the evergreen forests of North Kanara and the west coast down to Travancore; also the low country of Ceylon. The fruit is known as "wild olives," the fleshy outer portion of which is eaten in curries by the Natives, and pickled in oil and salt like olives. **D.E.P., iii., 206. Wild Olives.**

ELETTARIA CARDAMOMUM, *Maton & White, Trans. Linn. Soc.*, 1808, x., 229-55, tt. 4, 5; *Fl. Br. Ind.*, vi., 251; SCITAMINEÆ. This is often designated THE LESSER CARDAMOM or THE MALABAR CARDAMOM, though it perhaps would be more correct to speak of it as THE TRUE CARDAMOM, the so-called GREATER CARDAMOM of most writers (***Amomum subulatum***, p. 65) being in reality a substitute for the true spice. The Cardamom is in the Indian vernaculars—*eláchi, iláyechi* or *choti-* (small) *eláchi, illáchi, elechi, velloda, eláttari, elákai, éláki chettu, vittula, yálakki, yelaki, panlat, pala, bhálá, ensal, enasal*, etc. In Sanskrit it appears to bear the following names—*upakunchika* and *elá*. Hence *elá-tari* means the grains or seeds of *elá*, and *elákai* the *elá* plant or root. **D.E.P., iii., 227-36. Cardamom.**

Habitat.—It is a perennial herb, with thick fleshy rhizomes, having erect leafy stems 4 to 8 feet in height, and long much-branched inflorescences which arise near the ground. It is indigenous to West and South India, growing in the rich moist forests of the hilly tracts of Kanara, Mysore, Coorg, Wynaad, Travancore and Madura. It is fairly extensively cultivated, within the regions indicated, at altitudes of from 500 up to 5,000 feet. Although there are no botanical specimens in the Kew Herbarium to support the opinion held by some writers, namely that it is also wild in Burma, there would seem little doubt that it is cultivated in that province, especially in the Bhamo district. **Distribution.** Wild and Cultivated.

Varieties and Races.—There are apparently two well-marked cultivated plants which it seems must be regarded as deserving of separate recognition as at least varieties. In *Rees' Cyclopædia* (1819, xxxix., suppl.), the subject of ***Elettaria*** is discussed and divided into two sections (*a*) ***E. Cardamomum***, the **Varieties.** Two Forms.

Lesser or Malabar Cardamom, and (*b*) ***E. major***, the Greater Oblong Cardamom. The authorities mentioned for the second form can hardly be accepted as definitely denoting any particular plant, but rather one or other of the many cardamom substitutes. Moreover, the so-called form designated ***major*** is spoken of as a native of Java. This subject might not have been here mentioned but for the fact that Schumann (in Engler, *Pflanzenr.*, 1904, iv. (46), 269) describes the Ceylon ***Elettaria*** as a distinct species, and cites the above authority (Smith in *Rees, l.c.*). Hooker (Trimen, *Handbook Fl. Ceyl.*, iv., 261) makes reference to *var.* ***major*** and gives it the Sinhalese name of *ensal*, the Malabar plant being *rata-ensal*. But Thwaites tells us (*Enum. Pl. Zeyl.*, 1861, 318) that after a careful comparison of growing specimens, he was satisfied that the round and long fruited cardamoms of commerce were not obtained from distinct species. The forms above indicated may therefore be stated thus:—

Malabar Cardamom.

Var. α minor.—Leaves linear-lanceolate (much smaller and narrower than in β), the under-surface with a more or less complete coating of short white silky hairs. Inflorescence arising from the very base of the stems and creeping on the surface of the ground around the clumps, bracts shorter than the spikelets, acute. Fruits white, sub-globular, angled, somewhat coarsely veined.

he Les
ardam

This is the Malabar cardamom of Indian planters, and is admirably figured and described by Bontius, Rheede, Sonnerat, Maton and White, and also by Ludlow. An unpublished plate by Roxburgh shows the creeping inflorescence, bracts shorter than the flowers and fruits elliptic. It is, therefore, typical of this plant. He gives no drawing of the next form. Bontius claims to have been the first person to study in Java the living plant and to distinguish the lesser from the greater cardamom. There are good examples of the present form in the Kew Herbarium from Kanara, the Wynaad and Ceylon—the last mentioned being less hairy than the Indian, but said by Trimen to be "the Malabar cardamom of Ceylon planters." The present plant is, however, the lesser cardamom; the one which follows, being much larger fruited, is very possibly, in consequence, the greater cardamom of the early writers, though as already stated that name has been frequently assigned to the Nepal cardamom (***Amomum subulatum***).

Mysore Cardamom.
The Greater Cardamom.

Var. β major, *Thwaites, l.c.* 318; *Fl. Br. Ind.*, 251.—Leaves oblong lanceolate (broader and larger than in ***minor***), usually quite destitute of silky hairs (one Ceylon sample in Kew is sparsely hairy). Inflorescence at first erect, bracts larger (longer) than the spikelets and obtuse or apiculate. Fruit oblong, fusiform, minutely veined, twice the length of that of ***minor***.

Wild and Cultivated

Ceylo
Carda

This is the Mysore cardamom of planters, who speak of two forms of it, viz. *uru* (cultivated) and *kadu* (wild). It is a larger, more robust plant than the so-called Malabar. In the Kew Herbarium there are, however, examples of it from Malabar, Palghat, Ceylon, Mauritius and the Gold Coast. Thwaites and Baker say it is indigenous in Ceylon. Bontius observes that it occurs in the woods of Java, and he figures it as differing from the lesser cardamom by having an erect scape, longer pods and more hairy leaves. Some few years ago a large cardamom was regularly seen in the European markets and known as "Ceylon Cardamom." At the present day the Malabar form is grown in Ceylon and has displaced the former plant. Thus a large-sized true cardamom has been a well-known plant for many years, and it would almost seem as if it had been carried even further afield by cultivation (perhaps because hardier), than the smaller and finer spice. This, therefore, very possibly may have to be accepted as the Greater Cardamom proper.

Origin.

Origin.—Whether both these forms exist as wild plants and whether they originated respectively in Malabar and Mysore, as the planters' names would denote, are points which more careful study in the future can alone determine. It has been suggested that the Malabar is simply a higher state of cultivation than the Mysore and Ceylon. The plants are at all events sufficiently distinct to justify belief that they have been known to the Indian people for many years. It is significant also that the earliest faithful illustrations (such as the admirable plates given by Rheede) denote in every particular the Malabar, not the Mysore plant. So far as can be judged, the Malabar Cardamom, three centuries ago, differed in no respect from that of to-day. But no botanist (if Bontius' somewhat doubtful figure be disregarded) appears to have illustrated and described the Mysore form even down to the present time. These circumstances are opposed to belief in the ancestral stock of the Malabar having been the long-fruited Mysore plant.

Not Cultivated.

Lastly, Rheede makes no reference to either having been cultivated in Malabar

Three Forms.

Madagascar Cardamom.

Cardamom Substitutes.

during his time; on the contrary, he says the cardamom is not sown nor planted, but springs up after the forest is burned down. He then tells us of there being three forms on the mountains, thirty miles inland from Cochin and Calicut. It will be found below that Garcia de Orta, a century before Rheede's time, made practically the same observation except that he regarded the cardamom as cultivated. Rheede describes one of his plants as having round white fruits, another with longer but less valuable fruits, and the third pointed fruits, the least valued of all. It is thus quite possible that the two forms, the small round fruit and the elongated fruit, were both known to Bontius, as also to Rheede. Sonnerat, a century later, gives two admirable plates, one being undoubtedly the Malabar cardamom, and he speaks of its fruit as a round capsule with three angles or edges lengthwise, having many parallel nerves and divided within into three compartments, each with several black seeds. The Ghats (or coast mountains) of Malabar take the name, he adds, of "The Mountains of the Cardamom," from the abundance there of the plant, which grows wild and supplies the cardamoms of all the Indies. Farther on Sonnerat (*Voy. Ind. Or.*, 279) discusses a greater cardamom (under the name of *Amomum angustifolium*)—a plant which he says is wild in the island of Madagascar. It grows on marshy soils, and its cultivation has been undertaken in Mauritius. It has a reddish capsule, oval-oblong, almost triangular. He does not describe nor figure it as winged, like the "*bungali elachi*"—the greater cardamom of the Calcutta shops (see p. 65)—though it is doubtless another of the many large fruits of which ***A. maximum*** of Java, the nutmeg cardamom of the Arabs (*Pharmacog. Ind.*, iii., 436) and of the Bombay shops, as also the prickly cardamom of Tavoy—***A. xanthioides***—are cardamom substitutes that have been all at times designated Greater Cardamoms. [*Cf. Kew Mus. Guide*, ii., 9.]

History.

Garcia de Orta's Account.

Bontius.

Rheede.

History.—It is hardly necessary to attempt to furnish a detailed account of the early history of the Cardamom. Garcia de Orta was the first European who studied the plant practically in India (1563, *Coll.*, xiii.). He speaks of two kinds—*major* and *minor*, furnishes an accurate series of Indian and Ceylon vernacular names, and mentions that the Arabs know the two forms and had separate names for them. It is highly unlikely that the Nepal greater cardamom was carried to the west coast of India to be traded in by the Arabs at the time of Garcia's residence there, and it is certainly not so traded in to-day. Far more likely is it, therefore, that he alluded to the large and small fruited forms of ***Elettaria***, above described. But there are many surprises for the student of this subject, in Garcia's brief account. He says it was cultivated. Both varieties are found in India, chiefly in Calicut as far as Kananor and other parts of Malabar *and in Java*. An especially large kind, but less aromatic, was produced in Ceylon and carried to Hormuz and Arabia. This was doubtless the *var.* ***major*** above discussed—a plant also said to be indigenous to Ceylon. But it is significant that Garcia, after apparently a personal study of the plant and of the fruit, should have arrived at the emphatic opinion that the *eláttari* or *eláchi* of India was the cardamom of the Greeks, whatever that may have been (see **Capsicum**, p. 264). He says that the descriptions given by Galen, Dioscorides and Pliny do not agree with the Indian cardamom. Bontius, while agreeing that Pliny was wrong, takes exception, however, to Garcia's statement that it is cultivated and bears the fruits on the top like peas. In Java, Bontius says it is produced abundantly and its fruits are formed near the ground while the greater cardamom produces its fruits above. In this view Bontius and Garcia were practically followed by Clusius and the two Bauhins. Until the appearance of Rheede's account (approximately 100 years afterwards), the plant could not, however, be said to have been fully known in Europe. It is surprising that errors committed by Commelin (*Fl. Malab.*, 1696, 18), Burmann (*Thes. Zeyl.*, 1737, 54) and Linnæus (*Fl. Zeyl.*, 1747, 2) should have continued to disfigure the literature of the subject, during the succeeding century or so, until Maton and White established the genus ***Elettaria***.

[*Cf. The Bower Manuscript* (Hoernle, transl.), 1893–7, 80, 85, etc.; Januensis, *Liber Serapionis*, 1473, 61; Ruellius, *De Nat. Stirp.*, 1537, 48; Amatus, *on Dioscorides*, 1554, 12–4; Baber, *Memoirs*, 1519 (no mention); *Ain-i-Akbari*, 1590 (Blochmann, transl.), 64; Acosta, *Tract. de las Drogas, etc.*, 1578, 383; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), 1598, ii., 86–8; Clusius, *Hist. Exot. Pl.*, 1605, 185–6; Foster, *E.I.C. Letters*, 1901, iii., 108; v., 235; Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, 1629, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 126–7); Tavernier, *Travels Ind.*, 1676 (ed. Ball), 1889, i., 184; ii., 12–3; Rheede, *Hort. Mal.*, 1686, xi., 11, tt. 4–6; Alexander Hamilton, *New Acc. E. Ind.*, 1727, i., 298–9; Rumphius, *Herb. Amb.*, 1750, v., 152–3 (confused the Malaya with the Indian plant); *Amomum repens*, Sonnerat, *Voy. Ind. Or.*, 1782, iii., 272 *et seq.*, t. 136; Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, ii., 336–7, 510–12, 538; iii., 225, etc.; *Alpinia Cardamomum, Roxb.*, *Monandrous Plants in As. Res.*, 1810, xi., 355; also *Fl. Ind.*, i., 70–1; Milburn, *Or. Comm.*, i., 276–7; Ludlow, *Memo. Cardamom Cult. in Coorg.*, 1868; *Ind. For.*, 1884, x., 287–91; Foster, *Ind. For.*, 1893, xix., 1–5; Dymock, *Mat. Med. W. Ind.*, 1885, 786–8; *Admin. Rept. Coorg.*, 1889–1904; Nicholls, *Textbook Trop. Agri.*, 1892, 196–9; *Pharmacog. Ind.*, 1893, iii., 428–37; *Journ. Agri.-Hort. Soc. Ind.*, 1899, xi., n.s., 967–8; Woodrow, *Gard. in Ind.*, 1899, 482–3; Mollison, *Agri. Ledg.*, 1900, No. 11, 107–13; also *Textbook Ind. Agri.*, iii., 262–8; Schumann, in Engler's *Pflanzenr.*, 1904, iv. (46), 267–9.]

Cultivation.

Soil.

Climate.

Situation.

CULTIVATION.—Few recent writers have furnished either so interesting or so detailed accounts of the cardamom cultivation as those written during the first decade of the 19th century by White for Malabar and Buchanan-Hamilton for Mysore. It would occupy much space to deal with the centres of chief production separately, or the variations in method of cultivation and preparation that prevail. All that can be here attempted is a brief review of the salient points collectively. A fairly deep rich loamy soil, resting on rock, seems indispensable, and if possible this should be within undulating land, not too remote from running water. Shade and a humid atmosphere are essential it luxuriates in mists and fogs and cooling sea-breezes. Northern and western exposures are in South India accordingly considered the best. But all these conditions are not often conveniently combined, and hence the localities of successful production are somewhat restricted. Even within Malabar there are only certain tracts that can be spoken of as specially favourable.

Forest Lands.

Shade.

Felling of Trees.

Self-sown Stock.

Third-year Crop Obtained.

Life of Plantation.

Altitude.

1. ***Forest Production.***—The system described by Rheede still prevails. Small plots of land within the forests (called *elá-kandies*) where the wild or acclimatised plant is known to exist are cleared during February and March. The brushwood is cut down and burned, and the roots of powerful weeds torn up so as to free the soil. The shade, if too dense, is regulated by a certain percentage of trees being felled, thus admitting diffused sunlight; and, curiously enough (from the most ancient times to the present day), the disturbance or shaking of the soil, by the fall of heavy timber on it, is in itself deemed beneficial. At all events, soon after clearing, cardamom plants spring up all over the prepared plots; but if any reason exists for doubting the abundance of the future crop, young plants are deposited in the soil at the required distances apart. The plots are then left alone for a couple of years, and by that time the cardamom plants will have eight to ten leaves, and be a foot in height. In the third year they may be four feet in height. In the following May–June the ground is again weeded, and by September to November a light crop may be obtained. In the fourth year weeding is again given, and if the cardamoms are found growing nearer than six feet apart, a few are transplanted to new positions. A full crop is now obtained, and the plants may bear for three or four years; that is to say, the life of each plantation is eight or nine years. The seasons in Malabar are a little later than in Mysore, and according to some reports a full crop may even be obtained in the third year. It is also believed that above 2,000 feet the cardamoms grown are of a better quality than below that altitude.

Propagation.

Nursery.

Plants may be raised from seed or by division of the rhizome. They may be prepared in special nurseries. In about a year the seedlings will be a foot in length, and are then ready for transplantation. When raised by division of the rhizome, it should be seen that each cutting contains at least three perfect shoots. Holes a foot deep and six or seven feet apart each way are now dug all over the specially cleared plot or garden, and the seedlings or sets are deposited within these, but they must not be buried too deeply as they are liable to rot off. The flowering season is April to May.

Banking up.

It is a good plan to bank up around the clumps all leaves and rubbish obtainable, since this helps to support and encourage the growth of the creeping racemes. If at this stage the flowering branches (racemes) get submerged, the soil is washed away, the roots exposed, and the flowers and fruits ruined with the water and mud.

Proper Maturity.

The fruit should not be allowed to ripen fully, as the capsules will then burst and the seeds be lost. They should be collected just as they begin to turn from green to yellow.

Seasons.

In August and September they swell, and by the first half of October have usually attained the desired degree of ripening. The crop is accordingly gathered in October and November, and in exceptionally moist weather the harvest may be protracted into December.

Harvest.

A dry day is best for harvest. The scapes or shoots bearing the clusters of fruits are broken off close to the stems and placed in baskets lined with fresh leaves.

Treatment.

At night time they are carried to the temporary hut used by the men. After partaking of a meal and often working far into the night, the men separate carefully the capsules from the shoots, placing them as removed into a pit dug on purpose in the middle of the hut. In the morning the women arrive and carry the produce off to the homestead, where the further treatment is conducted. The fruits are spread out on carefully prepared floors, sometimes covered with mats, and are then exposed to the sun. At night they are carried within doors, as also during showers.

Drying.

Four or five days of careful drying and bleaching in the sun are usually enough, but in rainy weather artificial heat may be necessary, though the fruits suffer very greatly in colour when this course has to be resorted to, and are in consequence sometimes bleached with steam and sulphurous vapour or with *ritha* nuts (see p. 979).

Green Cardamoms.

The sun-dried cardamoms are the best, and in trade are spoken of as "green cardamoms." The capsules are now rubbed by the hand or shaken within mats, in order to brush off the pedicels, calyces, particles of dust, etc., then are winnowed, hand-picked and assorted according to size, colour and degree of ripeness, etc.—for on the racemes there must always be a percentage of overripe as also of underripe fruits.

Agricultural Lands.

2. ***Agricultural Production.***—Very little of a satisfactory nature can be learned of the systems pursued or of the extent of agricultural production in India. Mollison (*Textbook Ind. Agri.*, iii., 262) gives a brief but instructive account. He there speaks of the crop being extensively grown in the betel-palm and pepper gardens of the Sirsi and Siddapur Talukas of Kanara.

Situation.

It thrives under the same conditions of soil, etc., but by preference is grown in a cool, very shady garden with soil kept continuously moist. In Kanara the crop is chiefly raised from seed.

Seed.
Season.

The sowing season is September–October. But the beds require both shade and shelter from the sun and rain. If the seeds germinate too thickly they should be thinned out and the seedlings transplanted into rice seed-beds, but shaded by a temporary protection of palm-leaves.

Final
Transplantation.
Seasons.

When four feet high and fifteen to eighteen months old, they may be carried to their permanent positions and finally transplanted from March to June, or again from September to October. Pits 18 inches square and 18 inches deep are dug in the same lines as the betel-palms and intermediate between two trees. Into these pits the cardamoms are deposited and supplied yearly, in March and April, with leaf-manure. They come into bearing but do not yield much during the first year after transplanting.

Flowering.

The flowers appear somewhat irregularly in April and May, and the fruits form in June and July. The capsules are in season in September and October. Each should be severed from the scape and not plucked.

Plucking.

If plucked, the pressure of the fingers may burst the capsule.

Treatment.

After being dried in the sun for two or three days the fruits are hand-rubbed to remove the attached stalk and calyx. A too hot sun or too long exposure to the sun may dry the fruits (capsules) too quickly and thus cause them to burst and thereby to be lowered in value. In a fully stocked betel-nut garden there can be 300 to 400 cardamom plants to the acre. Yield. A well-grown plant may yield up to half a pound of dry cardamoms. Light showers in April and May are favourable. Bleaching. The fruits are dried and bleached in particular ways, according to the market for which destined. The waters of certain wells are moreover supposed to produce particular colours and flavours. The system above briefly reviewed is that also followed in Mysore—viz. production in betel-palm plantations.

Yield.

AREA AND YIELD.—Ludlow observes that when from one stem four scapes are thrown out, the crop is regarded as full; if only three, it is a three-fourths crop; if two, a half crop; if only one, a quarter crop. "One raceme will have from eight to fourteen branches, and each branch from three to six pedicels. When the crop is good, the branches are close together; when bad, the racemes are long and the branches far apart." "Fruit is occasionally borne on the upper part of the stem, but this is very rare." He further estimates that a garden of 484 square yards in area would give on an average 40 seers of green cardamoms or 10 seers of dry fruits. The actual yield, as published, by plantations is Different Returns. variously stated, and seems to range so greatly that the differences would be best accounted for by supposing that returns of green fruits had been contrasted with dry, or that they denoted diversities in stock rather than of soil or methods of cultivation. In Mysore 28 lb. are spoken of as the yield per acre, and in Ceylon 170 lb., although even as much as 400 lb. have been mentioned. In a circular issued by the Madras Government in 1903, the yield per acre is recorded as from 11 lb. to 700 lb. Omitting the extremes, the more important returns given in that circular were Dindigal, 93 lb.; Palni, 125 lb.; Kodaikánal, 250 lb.; Wynaad, 42 lb.; Calicut, 50 lb.; Uppinangadi, 49 lb.; and Kasaragod, 56 lb. The difference between green and dry pods has been expressed as four to five bushels shrinking to one.

Area: Madras.

Very little can be stated regarding the total area under cardamoms. There may be said to be two Indian areas, viz. the Madras and Bombay Presidencies. The former, which is often given the wider signification of South India, may, so far as cardamoms are concerned, be split up into (*a*) under British Indian Administration, or Madras proper; (*b*) the British Administration of Coorg; (*c*) under the Native State of Mysore; and (*d*) under the Native State of Travancore. Such particulars as are available regarding these areas are disjointed, and often do not refer to one and the same year. Cardamoms are of course returned under "spices and condiments," and it is only occasionally that the provincial details for these are forthcoming. The Madras Government published, however, in 1903, a statement of the cardamom area for the year previous. This showed *Madura*—(Dindigal, Palni, Periyakulam, and Kodaikánal)—as possessing 3,714 acres with a yield of 649,281 lb. *Malabar*—(Chirakkal, Kottayam, Kurumbranál, Wynaad, Calicut, and Ernad)—with 1,586 acres and 24,496 lb. yield. *South Kanara*—(Cundapur, Uppinángádi, and Kasaragod)—with 1,260 acres and 68,828 lb. yield. Totals. These give grand totals of 6,560 acres and 742,605 lb. **Coorg.** In the small British Province of Coorg there are said to be about 60,000 acres retained for cardamom-growing, with, in 1902-3, 1,107 acres actually under the crop and say 50,000 lb. production. **Bombay.** Turning now to the Bombay Presidency: in the official *Season and Crop Report* it is stated that the area in 1903–4 under cardamoms in the Kanara district came to 3,837 acres, or roughly half the area devoted to it in South India. If, for the purpose of comparison, the yield be accepted as on the same ratio, the production of Bombay should be 370,000 lb. In 1905–6 the area had increased to 4,573 acres.

Mysore and Travancore.

The available information regarding Mysore and Travancore outturn is even more unsatisfactory than for the British districts. A few years ago the Travancore Cardamom Hills Planters' Association was established, a direct indication of the industry having in South India (as in Ceylon) passed to some extent into the hands of European planters. Of 1903 it has been said that 4,000 acres of cardamoms were owned by European planters. According to Mr. Bourdillon there are some 26,000 acres returned in Travancore as the cardamom area. Doubtless only a small proportion of that is in any one year actually under the spice. The produce of the Travancore plantations has been given as 650,000 lb., or just a little under that of Ceylon, which is obtained from an area of 10,000 acres. The yield of the Mysore plantations would seem to be about 200,000 lb., and the cultivation would appear to be mainly in Kadur district.

All India.

The figures given above (if reliance can be put on them) would show a total production in all India of close on 2,000,000 lb. per annum. But that figure is mentioned purely and simply as suggestive, and must not be seriously accepted. In the *Annual Review of Forest Administration for British India*, issued by the Inspector-General, returns are given of cardamom-production within Forest Reserves. The volume for 1903–4 shows the value of the cardamoms exported to have been Rs. 3,37,000 as compared with Rs. 4,16,000 the previous year.

Trade.

Grades.

TRADE.—In the European markets cardamoms are spoken of under the terms "Shorts," "Short-longs" and "Long-longs." The "shorts" are from a quarter to nearly half an inch in length, and the "long-longs" an inch and over in length. The "long-longs" of modern commerce, it has been contended above, would seem to be the greater cardamom of early writers and the produce of the plant designated by planters the "Mysore or Ceylon cardamom." They are finely ribbed, of a pale colour, and the seeds are grey or almost white, and shrivelled when dry. The "shorts" are the Malabar or Wynaad cardamoms, and accepted as the finest grades, the ripe seeds of which are black.

Price.

In most recent reports the statement occurs that overproduction has lowered very seriously the price. It would appear that in many of the abandoned coffee plantations of Coorg, cardamom and orange cultivation has been attempted, and with some degree of success. There has all over the cardamom area been for some years past a steady expansion of production, so that no doubt there is some truth in the story of overproduction. Still, it cannot be exactly said that the limits have been reached of the world's demand for this spice, and a fall in price is naturally the first incentive to increased consumption. The *EXPORTS* to foreign countries during the undermentioned years have at all events shown an expansion in quantity and a shrinkage in price. They were in 1899–1900, 191,120 lb., valued at Rs. 3,27,750; in 1902–3, 302,940 lb., valued at Rs. 4,16,242; in 1905–6, 295,390 lb., valued at Rs. 2,97,513; and in 1906–7, 202,374 lb., valued at Rs. 2,19,172. Of that traffic Bombay and Madras are the chief distributing ports. The coastwise returns, moreover, show that Bombay drew on Madras for its supplies. Of receiving countries the United Kingdom usually takes the first place, and is followed by Arabia, Aden, Germany, Turkey-in-Asia, Persia and Egypt. But perhaps the most surprising feature of the traffic is the fact that India *IMPORTS* cardamoms very largely from Ceylon. In 1903–4 these imports came to 269,132 lb., valued at Rs. 1,98,710, and in 1905–6 to 435,407 lb., valued at Rs. 2,58,083—as much in weight, but comparatively less in value than the corresponding exports. We thus learn that India is itself by far the most important consuming country for cardamoms in the world.

Increased Consumption.

Foreign Exports.

Imports.

D.E.P., iii., 237–41. Rágí.

ELEUSINE CORACANA, *Gaertn.*; *Fl. Br. Ind.*, vii., 294; Duthie and Fuller, *Field and Garden Crops*, ii., 10, pl. xxviii.; GRAMINEÆ.

It has been established by Sir J. D. Hooker that *E. indica, Gaertn.*, is the wild form of which *E. coracana* is the cultivated state. There would therefore seem no urgent necessity to discard for the present the time-honoured name by which this millet has been known to those interested in the food supply of India. The wild plant is said to occur all over the low country and to ascend to altitudes of from 5,000 to 8,000 feet on the Himalaya. It is distributed throughout the tropical regions of the Old World, but only introduced into the New. As an Indian cultivated plant, however, it

Wild and Cultivated.

might be more correctly spoken of as met with chiefly on the hilly tracts. With the hill tribes of Southern, Western and Northern India it is an important article of daily food. It is mentioned in *The Bower Manuscript*, of the 8th century, and is the *rájika* and *rágí* of Sanskrit, and known in almost every vernacular language by names either derived from these or from what are possibly even more ancient aboriginal names:—*maruá*, *manduá*, *makra*, *mandal*, *mandwa*, *meruya*, *nángli*, *náchui*, *nachiri*, *nágli*, *kodé*, *kodou*, *koda*, *kodra*, *kayur*, *kévar*, *kelvaragú*, *kutra*, *kurakan*, *rotka*, *rágí*, *rágulu*, *tamidelu*, *taindulu*, *bávto*, etc.

Names.

Origin.

Varieties and Races. - There is perhaps little or no doubt that as a cultivated crop this originated in India. There are at all events three or four allied wild species regularly resorted to as articles of food in times of scarcity and famine. And moreover, of the cultivated plant there are in India several fairly distinct forms which almost of necessity denote antiquity of cultivation. ***E. stricta***, *Roxb.*, has the spikes quite straight and more numerous; is in consequence a very productive plant. Roxburgh, speaking of Rajamundry (*Fl. Ind.*, i., 344), describes this as the *pedda* (or great) *solu* and says it is a later crop than the ordinary *ponassa* (or early) *solu*. He then adds that there is still a third and even more productive form than either, namely the *maddi ruba solu*. It requires a rich soil but gives an increase of 500-fold.

Forms.

Early and Late.

Other writers refer similarly to early and late forms of this millet. Mollison (*Textbook Ind. Agri.*, iii., 56–60), for example, observes that in the Konkan and the Ghats districts the early crop is *halvi* and the late *garvi*; the former ripens about the end of September or early October, the latter at end of October or early November. It is therefore a rainy-season crop, and is usually sown on land that is too shallow or too poor for rice or too steep for terracing. But if the rainfall be well distributed it succeeds even on clay loams. The variability of the plant may in fact be regarded as a direct consequence of the class of soils on which grown. On stony and sandy soils the form that approximates most nearly to the wild state (***E. indica***) can alone be produced, and it is an inferior early crop. From that to the large and vigorous late forms of richer agricultural regions, an endless series of adaptations may be chronicled.

Adaptations.

Bengal.

CULTIVATION. - ***Bengal.***—Until it is recollected that Bengal has large tracts of mountainous country it cannot be realised why this province holds the second position of importance in the cultivation of the present millet. The Bengal districts of production may be given here in sequence of value:—Darbhanga, Bhagalpur, Hazaribagh, Muzaffarpur, Patna, Gaya, Shahabad, Sarun and Monghyr have each from 250,000 down to 40,000 acres under the crop. The normal total acreage under it is about one million acres, and the outturn has been put at 10 maunds an acre. Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 1833, 173, 182) describes the method of cultivation as a mixed crop with summer rice and ***Cajanus***. In connection with Bihar he says it is grown as a summer crop broadcasted or transplanted, but of Bhagalpur there are two crops, one gathered in November–December, and the other three months earlier. Basu (*Agri. Lohardaga*, 1890, 63–5; also *Palamau*, 28–9) calls *márúa* an upland cereal. There are two main varieties, an early red *lálká* and a late white *charká*; the former is a *bhádoi* crop which is harvested from August 15 to November 15, according to the season of sowing, the race of plant grown, nature of soil, and degree of rainfall. It is usually transplanted and has this advantage, that harvest can be deferred to suit the convenience of the cultivator. Col. J. J. Wood speaks of the *marúa* as widely and extensively grown in Chota Nagpur. Banerjei (*Agri. Cuttack*, 1893, 74–5) remarks that the *mandia* is an upland cereal and attains a height of 4 to 5 feet and bears grains of a reddish colour. The fields are prepared in May to July and the plants

Acreage.

Varieties.

Transplanted.

raised in a seed-bed and transplanted with the first good showers. The crop is ripe in August–September. The ears alone are cut off and the stems left in the ground to be browsed by the cattle. It will not grow on land that is inundated, nor even where the water lies for any time. It is essentially a crop of undulating well-drained soils.

Seasons.

Crop of Dry Soils.

U. Prov.

United Provinces.—This millet is unimportant in these provinces. The normal area under it does not much exceed 200,000 acres. It is, in fact, within the hill tracts only that it assumes importance. Of Allahabad it is said *marúa* or *makra* is sown on good soils near the villages sometimes with *juár*, more often alone and on manured land. The seed is broadcasted and ploughed in, but it may be transplanted from a nursery. Duthie and Fuller (*l.c.* 10), on the other hand, say of Jaunsar Bawar that it forms the chief article of food of the hillmen and is grown on the very poorest soil, often yielding a crop from mere stones and shingle. It is very rarely raised on the hilly country to the south of these provinces, where its place is taken by *kodon*. It grows, however, to a greater or lesser extent all over the provinces, and in the more fertile districts its cultivation is often attended with considerable care which results in a very large weight of produce. It suffers much from heavy rain, so much so that a good year for rice is generally a bad one for *mandua*. In Garhwal *mandua* is sown in April and reaped in October. It is often thinned out from one field and planted in another. In Kumaon it is cultivated both in ordinary agricultural lands and freshly cleared jungle. By October–November the crop is ripe and the ears are cut off, tied in bundles, and stacked for some twenty to twenty-five days, when they begin to ferment, and when warm are spread out and dried, then threshed. In Nepal there are two forms cultivated: one sown broadcast in May and June, the other raised in seed-beds and transplanted in June and July. Both forms grow and ripen in the rains. The broadcasted form is reaped in October, then transplanted in November. It is never, as a rule, sown on land suited for wheat, rice or sugar-cane.

Food of Hill Tribes.

Succeeds when Other Crops Fail.

Seasons.

Panjáb.

Panjáb.—In this province ***Eleusine*** holds a very subordinate position among the foods of the people, since the normal area under it does not exceed 40,000 acres. Baden-Powell (*Pb. Prod.*, 1868 245) says this is principally a hill product, but is also cultivated in Sialkot and a few other districts. In the Memoirs written by the Emperor Baber occurs a reference to *buzeh*, a kind of beer consumed by him on December 28, 1525, in or near the district of Sialkot. Mr. W. Coldstream, in a communication to the writer, says the grain of this pulse lasts in store much better than other grain. It is extensively grown in the Simla Hill States and comes into season in October. In the Kangra district it is an important food crop. In the Panjáb plains it is most frequently met with in the Karnál district, but chiefly in the Khádar. It is not uncommon in Jhang, especially in Chiniot. It is valued as a fodder crop, and may be cut two or three times in the rains.

Buzeh Beer.

Grain keeps well.

Fodder Crop.

Bombay.

Area.

Bombay and Sind.—Western India having extensive hill tracts, this millet becomes of considerable value. The normal area under it is about half a million acres. Dr. A. Gibson wrote a series of notes on the Agriculture of Western India (*Journ. Agri.-Hort. Soc. Ind.* (*Corresp. and Select.*), 1845, iv., 54–5), and the remarks he makes under this plant are well worthy of careful consideration. The form ***E. stricta***, he says, is met with in gardens below the Ghats, where alluvial soil and stream water are available, while ***E. coracana*** is the hill form, a smaller plant and much less productive. Mollison says that *nágli* occupies the fifth place among the Bombay cereals. In Kaira, Ahmedabad and Baroda districts of Gujarát, heavy crops are produced on highly assessed alluvial soil. Elsewhere the cultivation is chiefly confined to the poorer uplands of the Ghats. It is grown in districts of heavy rainfall, on land too light for rice. In Gujarat it is sometimes drill-sown, but is usually a mixed crop and most frequently transplanted. In the uplands of the Konkan and the Deccan it is often raised on steep land and is then broadcasted. For this purpose the soil is often burned with the brushwood (*ráb*), and the seeds are sown along with the ashes. The outturn varies so greatly that no general figure can be quoted. It may range from 700 to 1,600 lb. of grain and 2,000 to 2,400 lb. of straw.

Fifth Place among Cereals.

Seasons

Yield.

Madras.

Area.

Madras, Mysore, and Coorg.—South India is the chief region of *rágí* production. The normal area under it in the British districts comes to close on two million acres, but in Mysore State alone the area is usually well over two million acres, so that the total for South India might be put at 4½ million. The British districts of greatest importance are Salem, Coimbatore, Cuddapah, North Arcot, South Arcot, Trichinopoly, Anantapur and Vizagapatam, in the order enumerated. **Mysore.** The Mysore districts are Mysore, Tamkur, Bangalore, Kolar, Hassan, Chitaldrug and Kadur. As with other economic products so with this millet, Buchanan-Hamilton (*Journ. Mysore, etc.*, 1807, i., 100–3, 285–6, 297, 369, 375–8, 403; ii., 103–4, 254) is a valuable writer. **Varieties.** The Deccan Mussulmans, he says, call it *rágí*, the Tamil people *kevir*, and the farmers say there are three varieties—the *cari*, *kempu*, and *huluparia*. It is, near Seringapatam, customary to sow all three kinds in the same field. When the rains begin in June the field is drilled and ***Eleusine*** and ***Cajanus*** sown as a mixed crop. To appreciate the value of Buchanan-Hamiliton's account of this millet, the passages indicated above must be consulted. They have, however, been reviewed and amplified by Lewis Rice (*Mysore Gaz.*, i., 1897, 107–12, a work which is probably more accessible than the original). **Dry Soils.** *Rágí* is by far the most important single food crop of this State, especially on dry soils. It supplies the lower ranks of society with their chief food. The total area under food crops is usually 5¼ million acres, of which *rágí* alone occupies fully half.

Very little, however, can be added regarding the South Indian cultivation of this millet, to the account given in the *Dictionary*. **Four-mo Crop.** Stuart (*Man. N. Arcot*, 1895, i., 267–8) says it is a favourite four-month crop, the grain being largely used by the labouring classes. It is not a dainty food, but very nutritious. There are four varieties. It is grown both on irrigated and unirrigated land, but most commonly in that which is commanded by a well. When dependent upon rainfall alone it is sown so as to get the benefit of one or other of the monsoons, that is from May to June and from October to December. Under wells and tanks it is sown and reaped throughout the year. Only the ears of *rágí* are cut as they ripen, and, being heaped together for two or three months, the grain is beaten out with sticks or trodden underfoot by cattle. It should be kept some months before being used.

Utilisations. *MANUFACTURES.*—Incidental allusion has already been made to some of the edible preparations of this millet. **Preserving Quality.** It has the advantage not only that it may be left standing on the fields till a convenient time for harvesting, but the grain improves by being stored and may be preserved for many years without either being attacked by insects or becoming mouldy. These are circumstances of the greatest possible value, and have justified this millet being accepted as the most desirable for storage against times of scarcity and famine. **Paying Crop.** It is moreover one of the most productive of grains and one which will give a paying crop on soils from which hardly any other food can be obtained. It is essentially, therefore, to large tracts of India, the staple food of the poor, and, though not appreciated by fastidious tastes, is nevertheless wholesome. **Milled.** The seeds are milled and the "tailings" (the bran formed of the seed-coats) constitute an article of food with the very poor and one which is fairly largely used in the jails of South India. [*Cf. Agri. Ledg.*, 1899, No. 4.] **Husked Grain** The husked grain is reduced to flour and baked into cakes or boiled into puddings (about the consistency of blanc-mange). This is often improved by being cooked along with one-third rice or *cholam* flour. Church (*Food-Grains of Ind.*, 1886, 89) has given attention to the chemical composition of both the grain and the tailings of this millet. **Beer.** Lastly, numerous writers allude to a beer and spirit prepared from the grain. One of the earliest and most curious passages on this subject is that given by Baber (*Memoirs*, 283, 294). This has already been alluded to, but the Emperor's remarks regarding the people of Sowad, Bajour and the neighbouring countries, who make a peculiar kind of *buzeh* (or beer) may be here quoted:—**Kim.** "There is a substance which they call *kím* composed of the tops of certain herbs and of various drugs. They make it round like a loaf, and then dry and lay it up. This *kím* is the essence from which the *buzeh* is made. Many of the potions composed of it are wonderfully exhilarating, but they are terribly bitter and ill-tasted. I had thought of taking this *buzeh*, but, from its extreme bitterness, was unable to swallow it: I then took a little *májun*." **Drinking-parties.** The Emperor repeatedly refers to his special drinking-parties, held not infrequently on board pleasure boats, and the gusto with which he narrates his experiences might easily enough have originated the English expression "bousing"—or deliberate intoxication with *buzeh* (beer). Mr. (now Sir Arthur) Wollaston tells me that *buzah* or *buza* is Turkish, meaning a drink prepared from corn, and that it had been adopted into Persian with the meaning ale or beer. Shaw (*Travels*, 1757, 407) says: "Besides the use that is commonly made of barley to feed their cattle, the Egyptians, after it is dried and parched, make a fermented intoxicating liquor of it, called *bouzah*, the same, probably, with the *oinos krithinos* of the ancients. This is very copiously drunk by the lower rank of people." (See remarks regarding *boza* and *múra* under **Cannabis sativa**, p. 257). In the Maráthá country the fermented liquor of ***Eleusine*** is called *bojah* or *bojali*, and 100 years ago it was perhaps more extensively made than to-day. Hove (*Tours in Gujarat, etc.*, 1787, 21) speaks of the adulteration of *mowra* liquor with ***Acorus*** root. The liquor in question may have been the *marua* (***Eleusine***), or of course it might have been *mahua* (***Bassia***), which Hove in another passage calls *mawra*. In Kumaon it is called *daru* (**Bassia**, see p. 119). A similar beer is made here and there all over the Indian area of ***Eleusine***, and throughout the Himalaya from Kashmir to Sikkim. It is, however, displaced in Assam and the Naga hills by the beer made from ***Coix*** (*dzu*, see p. 396), also more recently by European **Malt Liquors** (see pp. 757–8).

Total Production.

Area, Yield and Trade.—The total area for all India devoted to this crop averages from 5½ to 6¼ million acres, of which nearly two-thirds are in South India. It is possible that were returns for Hyderabad (Deccan) and other States (not at present obtainable) added to the returned area, the grand total would not be far short of 7,000,000 acres. The yield is variously stated at from 5 to 10 or more maunds per acre. If a yield of 400 lb. be accepted as a safe mean average, expressed to the estimated acreage that would show an annual production of 25,000,000 cwt. of edible grain—a by no means insignificant item in India's food supply. To South India, which approximately consumes two-thirds of that amount, it is an exceedingly important article of diet. There is no mention of this millet in the foreign trade of India, so apparently the produce is entirely consumed within the country.

Seven Million Acres.

Twenty-five Million Cwt.

ERIOBOTRYA JAPONICA, ***Lindl.***: *Fl. Br. Ind.*, ii., 372; Firminger, *Man. Gard. Ind.* (ed Cameron), 250; ROSACEÆ. The *loquat* or Japan Medlar.

D.E.P., iii., 257.
Loquat.

A tree indigenous in China and Japan: cultivated in Northern and Eastern India, and, like the *litchi* and other Chinese plants, is most successfully grown in Assam. The fruit is much appreciated and comes into season about the middle of March, and may be purchased almost everywhere in India for six weeks or two months thereafter.

ERIODENDRON ANFRACTUOSUM, ***DC.***: *Fl. Br. Ind.*, i., 350; MALVACEÆ. This is the WHITE SILK-COTTON TREE, the KAPOK TREE of the Dutch, and in India is the *safed simal, senibal, katan, hatian, shameula, katsawar, ilavam, buruga, pur, kadami, dúdi mara, pania*, etc. Is a moderate-sized tree fairly plentiful in some parts of Western and Southern India and Burma, but doubtfully indigenous. Largely planted around villages and temples, and if a demand arose for it, of sufficient importance, its production might be greatly extended.

D.E.P., iii., 258–64.
Kapok.

History.—Jacobus Bontius (*Hist Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 105) was perhaps the earliest author to figure and describe this tree. He lived in Batavia in 1629, but it is not quite clear whether his *Abor Lanigera* (which he identifies with the *Gossampines* of Pliny (bk. 12, ch. 10, 11) had been seen by him in the Malaya or in India. His engraving though quaint, is unmistakable, but he describes the tree so minutely that without his figure even, there would be little difficulty in identifying the plant as ***Eriodendron***. The oblong pods produce wool that cannot be carded as it is too short, but throughout India it is sought for as a material with which to stuff couches and cushions. It is in passing worthy of remark that Bontius makes no mention of the true cotton, nor of the red-silk-cotton tree, both of which he must have seen in India at least. From this silence it may be inferred that the *Abor Lanigera* was a Batavian tree. Rheede (*Hort. Mal.*, 1682, iii., tt. 49–51) gives a sketch of it not unlike that of Bontius, but his other pictures might be described as quite as good as many others produced up to two centuries later. He tells us that it occurs everywhere in Malabar and bears fruit in January and February and puts on fresh leaves in March and April. Hence if it be not indigenous to India it must have been introduced at a very early date.

Gum.
Tan.
Fibre.
Oil.
Wood.
Silk-cotton.
Upholstery.
Trade.

Properties and Uses.—From the bark a medicinal GUM is obtained; the wood is employed as a TANNING material for leather, and from the bark an inferior bast FIBRE is sometimes prepared. The seeds yield 28 per cent. of an OIL that much resembles cotton-seed oil, and the cake is found to be a highly beneficial cattle food. The oil is used in Holland as food and in the manufacture of soap. It dries more rapidly than cotton-seed oil. The WOOD is of poor quality, and is only of use in the construction of toys. But interest in the plant may be said to be concentrated in the FLOSS or SILK-COTTON obtained from the fruits. This is known to commerce as *kapok*, a Dutch-Malay word derived apparently from the Sanskrit *karpási* just as the most general Indian name for the tree is *hatian*, a word derived from the Arabic *katan*, and thus its names suggest the similarity of the floss to cotton. Gamble (quoting Trimen) very properly remarks that the *kapok* cotton is obtained, not from the testa of the seed but from the wall of the capsule. This is perhaps more than a botanical peculiarity, and doubtless accounts for some of the characteristics of the floss, which is used in nature as a packing material for the seeds, but is not, like cotton, formed from the seeds themselves. *Kapok* is of better quality than the corresponding cotton of **Bombax** as it is more elastic, and when used for upholstery is less liable to knot. Both Bontius and Rheede (as already shown) mention that the cotton is used in stuffing couches and cushions and is held in great esteem because of its softness. Rumphius (*Herb. Amb.*, i., 196, t. 80) tells us that in his time (1750) the tree was very abundant in Java and had been carried from there to most of the Malayan islands. He further remarks that although the fibre is too short to spin, it is largely used for filling cushions and has the advantage of not being, like ordinary cotton, easily rolled into balls. During the Colonial and Indian Exhibition of London (1885-6) I showed samples of Indian *kapok* and other silk cottons and urged the claims of this particular fibre to attention. It is only within the past decade or so that the subject seems to have attracted the notice of Indian merchants as being something more than a curiosity. It would thus almost seem as if the plant had been in India more highly esteemed over two centuries ago than to-day. And it is precisely in upholstery that the fibre has in Europe come into prominence. Fairly largely exported from Java. In 1898, for example, the traffic came to 51,919 bales, and in 1901 to 74,123 bales. Of the last-mentioned year's consignments 45,631 bales went to Holland, 23,192 bales to Australia, and 5,300 bales to the United States. The supply received by Holland in 1903 was 51,918 bales. Ceylon would also appear to have commenced to export this fibre. India exports none, and the local demand even is insignificant, **Bombax** floss (see p. 168) taking its place.

Felts.
Life-belts.
Upholstery.
Sterilised.

According to some writers the increasing demand for this floss in Europe necessitates belief that it is being used for textile purposes. But it is too fine, light, smooth and slippery to be easily spun, unless used as an admixture with other flosses. It is reputed to be employed in Bordeaux for the manufacture of soft non-conducting felts. Attempts have unsuccessfully been made to blend it with the fur fibre of the coney and hare, in the production of the "nap" of silk hats. The Kapok Supply Company of London announce that they are now using it very largely in the construction of life-belts, lifebuoys, etc., and that it is regarded as superior to cork or hair since much more buoyant, softer and cheaper. Life-jackets may be padded with *kapok* and rendered waterproof by being lined with waterproof cloth. It is, however, as already mentioned, in upholstery mainly that *kapok* has found its most important use. It is largely worked up for cushions, pillows, chairs, bedding, etc., in Holland, Germany, Australia and the United States, but only to a comparatively small extent in England. For these purposes its non-hygroscopic character, its softness and resiliency render it peculiarly suitable. It is also less absorbent, less liable to harbour insects, and can be sterilised by heating at least three times without being seriously damaged. With so much to recommend it, the apathy preserved in India is remarkable; but there is this to be said as possibly explanatory, viz. that so far the Indian floss has fetched less than that of Java. This is by some believed to be due to defective methods of collecting, cleaning, packing, pressing, etc.; by others, and perhaps with greater reason, as due either to climate or stock of plant grown. Certainly the opinion advanced by some writers (in the Indian press particularly) that

Semal versus *Kapok.*

kapok is but a Dutch name for the well-known *semal* cotton—the floss of ***Bombax*** —is quite erroneous; the floss of ***Eriodendron*** is far superior to that of ***Bombax***, and the two must never be confused with each other. The best qualities of Java *kapok* are said to fetch from 7*d.* to 9*d.* per lb., the Indian not much more than half those sums. The double profit of floss and oil-seed should make the cultivation of *kapok* profitable in all hotter moist tracts of India that possess an insular climate. The subject is being vigorously taken up in both the French and German colonies, and is well worthy of special consideration in India [*Cf.* Watt, *Select. Rec. Govt. Ind.*, 1888, 329–39; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 66; Cameron, *For. Trees Mysore and Coorg*, 1894, 30–1; Morris, *Kew Bull.*, 1896, 204–7; also *Cantor Lect.* in *Soc. Arts*, 1895, 897 *et seq.*; Dodge, *Useful Fibre Plants of the World*, 1897, 160; Gamble, *Man. Ind. Timbs.*, 1902, 91–2; Talbot, *List Trees, etc.*, 1902, 40; Hannan, *Textile Fibres of Comm.*, 1902, 71; Cooke, *Fl. Pres. Bomb.*, 1903, i., 121; Wiesner, *Die. Rohst. des Pflanzenr.*, i., 264–6; Perrot, *Prod. Bombax et Kapok*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. i., 22–39; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 68, 368.]

Price.

D.E.P., iii., 268–70.

ERYTHRINA, *Linn.*; *Fl. Br. Ind.*, ii., 188–90; LEGUMINOSÆ. A genus of trees with prickly branches, large pinnate 3-foliate stipellate non-glandular leaves and conspicuous racemes of papilionate flowers, the petals being very unequal so that the standard is much the largest. There are some seven or eight species indigenous to India and widely cultivated remote from their truly wild habitats. They are the CORAL TREES (or Mochi-wood trees of Madras), the *parijáta* of the Sanskrit, and their generic vernacular name is *mandar* or *madar.*

E. indica, *Lamk.*; a native of Bengal near the sea, cultivated elsewhere; is the *pálitá-mandar*, *paringa*, etc., and may be recognised by its blackish prickles. Perhaps this is the species figured and described by Bontius (in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 135) in 1629. **E. lithosperma,** *Blume*, is a native of Burma, Java and the Philippine Islands. A favourite with some of the coffee planters. It has large broad leaves and is often almost devoid of prickles. **E. suberosa,** *Roxb.*, is a native of the more interior tracts. It is characterised by having a thick corky bark and is the *pángrá* (or *pángárá*), *mandal*, *muni*, etc.

Shade-trees.

These and other species have from the most ancient times been employed in Indian agriculture as shade-trees and as supports for climbing plants. The belief is universal that they exercise a beneficial influence on the soil, though the explanation of this circumstance, like the employment of clover in Europe, remained inexplicable till the discovery had been made of the value of the root tubercles of those plants in harbouring nitrogen-feeding bacteria. The following crops may be mentioned as those specially noted in which these trees are used— ***Areca*** palm (p. 84), ***Coffea*** (pp. 379, 383), Pepper-vine (p. 899), and Tea (p. 228). [*Cf. Agri. Journ. Ind.*, 1907, ii., pt. 1, 83.]

Nitrogen Fixation.

ERYTHROXYLON, *Linn.*; LINEÆ. A genus of shrubs or trees of about fifty species, natives of warm countries, six of which are Indian.

D.E.P., iii., 270–7. Coca.

E. Coca, *Lam.*; De Candolle, *Orig. Cult. Plants*, 1884, 135; Warden, *Erythroxylon grown in India, Journ. Agri.-Hort. Soc.*, 1888, viii., n.s., 127–57; Hooker, *Bot. Mag.*, 1894, 7334; *Cat. des Pl. Econ. pour les Colon.*, "*L'Hort. Colon.*," 1900, 78; Rusby, *Drugg. Circ. and Chem. Gaz.*, Nov. 1900; Greenish, *Pharmaceut. Journ.*, 1904, 493–6; Nicholls, *Textbook Trop. Agri.*, 1892, 234–7; Heuzé, *Les Pl. Indust.*, 1895, iv., 251–5; Wright, *Coca*, 1907, 75, 109, etc. This is found in various parts of South America, but according to De Candolle is indigenous only to Peru and Bolivia.

Introduction into India.

Introduction into India.—The Coca plant was introduced into Ceylon from Kew in 1870. At a committee meeting of the Agri.-Horticultural Society of Madras in May, 1876, a letter was read from Mr. Joseph Stevenson in which he suggested the propagation of the plant, in view of the probability of its becoming an important article of commerce. No steps, however, were taken till 1885, when, owing to the discovery of the value of cocaine as an anæsthetic, the demand in Europe for the Coca leaf was rapidly increased. About then the Agri.-Horticultural Society of India distributed young plants from their Calcutta Gardens to the various tea-growing districts, and in the same year the Government of India addressed the Secretary of State for India, with a view to ascertain the method of preparation of the leaf as pursued in South America.

Cultivation.

The Leaves.

Crystalls
Cocaine

Soil.

Two For

High Rainfall.

Cultivation.—Various attempts have, however, been made to grow ***E. Coca*** in India. Those in the Sikkim (Cinchona plantations) were a failure, but on the slopes of the Nilgiris and other parts of the Madras Presidency the plants have thriven much better. The slightest degree of frost appears to be fatal, and for this reason cultivation on the higher Himalaya has been abandoned, but at lower altitudes, from about 100 to 2,000 feet above sea-level, more encouraging results have been obtained. It is said that in Assam and Sylhet the plant has been grown satisfactorily. But it is affirmed that several species, besides the one here specially indicated, are employed as sources of cocaine, in addition to not a few well-recognised varieties of the true cocaine plant. From the leaves the crystallisable drug is obtained. Some of the species contain a large quantity of the drug not in a crystallisable form, and in consequence are comparatively valueless. It is, therefore, essential to obtain the correct plant, and to know whether the climate and soil of a proposed new plantation favour the formation of crystallisable cocaine. It is usually affirmed that for that purpose a rich and light soil is required. In other words, the plant is grown most successfully on well-drained moist loams, rich in humus; but as it exhausts the land, manuring is necessary after heavy cropping. There are said to be two chief varieties, one with small, the other with large leaves. These may be raised from cuttings, but if cultivated to any extent, seedlings should be produced in nurseries and the young plants put out into the fields when from 8 to 10 inches high. A writer in the *Journal of the Agri.-Horticultural Society of India* urges the necessity of a liberal supply of water to aid in germination. High rainfall is essential for the growth of the plant. In the Andes the only climatic variation is in degrees of humidity, and it rains more or less every month. The first harvest may be expected eighteen months after the time of planting, and once successfully established, the shrubs yield for forty years.

Collection.

Age.

Drying.

Packing.

Separation of Alkaloids.

The leaves are ready for gathering when they become rigid and break on bending. Two, three or even four crops may be obtained in one year from strong plants in rich soil. The leaves are picked singly, but care must be taken not to pluck leaves nor shoots too young. A dry day should be chosen for harvesting and the picking should not be carried beyond noon, so that the leaves may be exposed several hours in the sun to dry. In India various methods of artificial drying in tea-driers or charcoal *chulas* have been experimentally tried. The dried leaves should be put aside for a day or two, and then packed. The best method of packing coca is to seal it up as soon as it is perfectly dry, in air-tight packages, similar to those used for tea. Shipping should take place as soon as possible, for the leaves keep in good condition a much longer time in temperate climates than in the tropics. No commercial attempt has as yet been made to separate the alkaloid and its salts in India, though reports have appeared of the results obtained in the laboratory with Indian leaf. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1900-1, 20-1), records, for example, the results of his examination of samples from Assam and the Wynaad. It was found that the leaves rapidly deteriorate if kept for any length of time, more especially if imperfectly packed.

Medicine and Chemistry.

Alkaloids.

Anæsthesia.

The leaves have the property when masticated of communicating a remarkable sustaining power, due to their containing cocaine. On this account they are chewed by the Peruvian Indian, and are to him what *betel pan* is to the Hindu, *kava* to the South Sea Islander, and tobacco to the rest of mankind. Both the alkaloid and its salts are stimulant and restorative. Injected hypodermically or painted externally, they produce local anæsthesia, and are much used in minor operations, particularly in ophthalmic and dental surgery. Its employment in this form was first recommended by Dr. C. Koller of Vienna in 1884, though the anæsthetic action was known twenty years previously. [*Cf. Kew Bull.*, 1889, 1-13; 1894, 151-3; *Pharmacog. Ind.*, 1893, iii., 131-4, app.; Garsed, *Brit. and Colon. Druggist*, 1901, xl., 413; Lenton, *Pharmaceut. Journ.*, 1903, lxx., 390-1, 420-1; Garsed, *Pharmaceut. Journ.*, 1903, lxxi., 784-91; Hooper, *Coca and Cocaine Habit, Lecture in "Statesman,"* Feb. 19, 1904; Picket, *Veg. Alkaloids*, 1904, 232-7; White and Humphrey, *Pharmacop.*, 1904, 136-40.]

Trade.

Trade and Cocaine Legislation.—The records of the traffic in the drug are very meagre. The world's supply comes chiefly from South America, but recently Ceylon has begun to export a small amount. India is thus mainly interested in the import traffic, and the repressive measures of the Government. The quantity imported was returned in the official statistics for the first time in 1903, when it amounted to 1,400 oz., valued at Rs. 18,442. In 1904–5 it was 5,431 oz. (Rs. 59,916), and in 1906–7, 1,771 oz. (Rs. 19,999). Hooper has published a graphic sketch of the growth of the Indian habit of cocaine indulgence. This has also been fully discussed by Dr. K. C. Bose and other writers (*Ind. Med. Gaz.*, Oct. 1901; March 1903). The Bengal habit seems to have originated in Bhagalpur, and spread to Calcutta. Shortly after it was carried to Bombay and Rangoon. So rapidly and alarmingly was this new vice being taken up that the Government of Bengal, with most praiseworthy zeal, in which it was also followed by the other Governments and Administrations, adopted repressive measures. In a notification of October 24, 1900, cocaine was included in the definition of "intoxicating drugs." In February 1902 the sale of the drug without a license became illegal. A further enactment of December 1, 1903, limited the amount that could be held or sold at one time. In consequence importations that would have exceeded the limits of possession were seized by the Customs authorities, and returned to the countries from whence procured. It can thus be affirmed that a wholesome check has been given which it is hoped may in time completely repress this most pernicious utilisation of an otherwise valuable medicinal agent.

Imports.

"Intoxicating Drugs."

D.E.P., iii., 277–8.
Bastard Sandal.

E. monogynum, *Roxb.*, *Fl. Ind.*, ii., 449; *Fl. Br. Ind.*, i., 414; Talbot, *List Trees, etc.*, 53; Gamble, *Man. Ind. Timbs.*, 116–7. The Bastard Sandal or Red Cedar, *dévadáram, nát-ká-deodár, simpuliccai, sammanathi, thasadaram, chembulichan, benáde, huli, kuruvakumara, jivadali, kumbulukay, dévadáru, adavigóránta, gathiri.* A shrub or small tree found in the dry forests of the Deccan, Karnátak and Ceylon.

Oil.

The wood is said to yield an OIL, used as a preservative for Native boats. It resembles tar, and is known in Ceylon under the name of *dummele.* It is extracted by packing pieces of the wood in an earthen pot inverted over a similar pot which is surrounded by fire.

Medicine.

Famine Food.

As a MEDICINE, Moodeen Sheriff (*Mat. Med. Mad.*, 73) describes the plant as possessing stomachic, diaphoretic and stimulant diuretic properties. In several parts of India the leaves and fruits are used as food in times of famine; in fact they might almost be said to be regularly eaten as a green vegetable. It is reported (*Ind. For.*, 1900, xxvi., 619) that during a recent famine in the Mysore Province the leaves had been largely eaten by the poorer classes. The time for gathering varies from June to December. They are boiled and mixed with salt and chillies. Dr. Bidie suggested that "probably the leaves contain some principle like that of ***E. Coca***," but specimens analysed by the Government Quinologist in Madras were proved to have no anæsthetic property, but to possess a bitter tonic principle which might serve to mitigate the pangs of hunger. [*Cf.* Cameron, *For. Trees. Mysore and Coorg*, 1894, 44; Biscoe, *Hyderabad Trees*, 1895, 6; *Ind. Pharmacol.*, 1896, 55.]

EUGENIA, *Linn.* This genus of MYRTACEÆ embraces over 700 species, 120 of which are trees met with fairly plentifully in India. A few (such as the Clove, the Rose-apple and the Jaman-plum) are of considerable importance. Most modern botanical writers break up that vast assemblage of plants into three genera (or sub-genera) under the names ***Jambosa, Zyzygium*** and ***Eueugenia***. The less important Indian species may be disposed of at once and the major portion of the available space devoted to the clove, which although not a native of India, is nevertheless traded in all over the country so universally as to make it one of the most important of spices, and one which the future may see produced very much more largely by Indian planters.

D.E.P., iii, 284–5. Jaman Plum.

E. (Zyzygium) Jambolana, *Lam.; Fl. Br. Ind.*, ii., 499; the Black plum, Jaman-plum, *jámbu, jáman, jám, jámbul, kuda, nával, nerale, zebri, thabyebyu*, etc., and *perin-njara*, according to Rheede (*Hort. Mal.*, 1676, v., t. 29).

Varieties. Wine. Brandy. Medicine. Silkworms. Timber. Sacred.

A small evergreen tree met with throughout India and Burma, ascending the hills to about 6,000 feet. Is chiefly found along river-beds and is specially cultivated for its FRUIT in gardens (*topes*) and in avenues. There are several varieties that yield much better flavoured fruit than others, but as a rule it is astringent, and only serviceable when cooked in tarts and puddings. In Goa a wine is prepared from it, and a spirit (*jambava*) is spoken of, by recent Sanskrit authors, as distilled from the *jambu*. Some years ago brandy was made at Monghyr from the fermented fruit. The *jáman* is extensively used all over India in the manufacture of vinegar (see pp. 1109–10). Recently attention has been directed to the SEEDS as a cure for *Diabetes Mellitus* (Christy, *New. Comm. Pl.*, 1893, No. 8, 77; *Pharmacog. Ind.*, ii., 25–9). The *tasar* SILKWORM is said to feed on the leaves of the tree. The TIMBER is fairly durable and is largely employed for building purposes, for agricultural implements and for well-work, since it resists the action of water. It gives a good fuel. The *jámbu* is one of the trees held in veneration by the Buddhists (Monier Williams, *Buddhism*, 576), and is often planted near Hindu temples because regarded as sacred to Krishna. [*Cf.* Baber, *Memoirs*, 325; Garcia de Orta, *Coll.*, xxviii.; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 29; *Taleef Shereef* (Playfair, transl.), 65; Buchanan-Hamilton (*Stat. Acc. Dinaj.*, 156), etc.]

D.E.P., iii., 287–8. Rose-apple

E. (Jambosa) Jambos, *Linn.*; *Fl. Br. Ind.*, ii., 474. A small tree cultivated here and there throughout India, and probably wild in Eastern Bengal and Assam. The Rose-apple, *gulab-jáman* (*i.e.* rose-*jáman*) and *nati-schambu*, according to Rheede (*Hort. Mal.*, i., t. 18).

This fruit is met with throughout Northern and Eastern Bengal, Assam, Manipur, and the Naga hills, and has in these countries all the appearance of having been long acclimatised, if not indigenous. The FRUIT is produced during the rainy season, and is about the size of a small apple. By many persons it is highly esteemed on account of its delicate flavour, but is not juicy enough to be a universal favourite. The tree is very ornamental, and is often seen in gardens even where the fruit is not appreciated. [*Cf.* Boym, *Fl. Sin.*, 1656, pl. F.; Buchanan-Hamilton, *l.c.* 196; Robinson, *Disc. Acc. Assam.*, 1841, 43.]

D.E.P., iii., 288. Malay Apple.

E. (Jambosa) malaccensis, *Linn.; Fl. Br. Ind.*, ii., 471. The Malay Apple, the *karika* tree, *malaka jámrul*, and *malacca-schambu*, according to Rheede (*Hort. Mal.*, i., t. 17).

A handsome tree, native of the Malaya but cultivated in Bengal, South India and Burma on account of its fruits which are large and juicy, though rather insipid. [*Cf.* Garcia de Orta, *Coll.* xxviii.; Acosta, *Tract. de las Drogas*, 1578, 268; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 29; Forster, *Pl. Esc.*, 1786, 36.]

D.E.P., iii., 289. Rai-jáman.

E. (Zyzygium) operculata, *Roxb.; Fl. Br. Ind.*, ii., 498. The *rai-jáman, paiman, kiamoni, junsong, boda jam.*

A moderate-sized tree of the Sub-Himalaya from the Panjáb to Assam, Orissa, N. Circars, Burma and Ceylon. It yields an edible FRUIT which ripens toward the end of the hot weather. It is a valued tree in reclothing the grassy banks in the *sal* and mixed forests, especially of North India. The TIMBER, while not as good as *jáman*, is employed for building and in the construction of agricultural implements.

D.E.P., ii., 202–6. Clove.

Eugenia caryophyllata, *Thunb.* **(Caryophyllus aromaticus,** *Linn.*); Woodville, *Med. Bot.*, 1810, iii., 538–40, t. 193; Smith, *Rees' Cyclop.*, 1819, vi.; Hooker, *Bot. Mag.*, 1827, nn. 2749–50; *Jambosa caryophyllus*, *Ndz.*, Engler and Prantl, *Pflanzenfam.*, 1893, iii., pt. vii., 85.

European Names.

History.—The name Clove denotes its resemblance to a nail (*clavus*), hence *clavo* (Sp.), *clou* (Fr.), *nelken* (Germ.), and *mekhak* (Pers.). In later Sanskrit it

Earliest Record in India.

Sanskrit Names.

South Indian Names.

is *lavanga*. Mr. F. W. Thomas (whom I have had the pleasure of consulting on this subject) tells me that the earliest occurrence of the name is in the *Ramayana*; Charaka is the first medical writer who alludes to the clove. But the word *lavanga* has passed into most of the more recent languages of India, and become *lawanga, lavinga, labang, laung, langa, lóng, raung*, etc., thus showing a common source. Mr. Thomas, commenting on the possibility of *lavanga* being a Sanskrit word, says, "I should think that the chance of its being Malay is the greatest. It has a Malay appearance. . . . In Malay *bunga lavang* is the term used, *bunga* meaning gay or variegated, especially a flower. *Lavang* by itself seems to be used for 'mace.'" [*Cf.* Reinwardt, *Reis in den Indischen Archipel.*, 1838, 465; Uhlenbeck, *Sanskrit Etymology*; *Encyclop. van Nederlandsche Indie.*] But, in addition, the clove bears in South India the names *kirámbu, karampu*, etc., words which Dymock (*Mat. Med. W. Ind.*, 1885, 328) suggests may have been the source of the *caryophyllon*. But it is probably more safe to assume that these South Indian names were derived from the Greek, through the Arabic *karanfal*. The Tamil name for ***Cinnamomum zeylanicum*** is *lavanga*, and Crawfurd (*Dict. Ind. Islands*, 1856, 215) gives that as the Borneo name for the clove-bark—a species of Cinnamon. In another passage (101–2) Crawfurd observes that *lawang* is a name used by the Malays for the clove, but brought to their country by the traders from India. Another name for the clove (in the Malaya), he says, is *gaumedi*, a word which Prof. Wilson, it would seem, translated "Cow's marrow" and regarded as of Sanskrit origin.

The Clove thus bears no undoubted Indian aboriginal names, and was probably not known in India much before the 5th century. The clove is not mentioned in the *Periplus* (63 A.D.) among commodities carried from India. There would seem, moreover, no doubt that it is the *caryophyllon* of Paulus Ægineta (Adams, transl., 1847, 160)—a Greek physician who wrote about the close of the 6th century A.D., and who speaks of the spice in such terms as to imply that it was well known. Passing over several centuries, it may be observed that Caspar Bauhin (*Pinax Theat. Bot.*, 1623, 410) was correct when he pointed out that Serapion was in error citing Galen. The account of the *gariofilus* given by Serapion (9th century), Avicenna (10th century), and by other Arabs is literally transcribed from Paulus.

Arab Knowledge.

Eastern Travellers.

Travellers in India.

It is a well-established fact that the Chinese traded with Amboyna and India at a time anterior to any definite knowledge of these countries being possessed by the inhabitants of Europe. The Arabs also had a direct commerce of their own with India and the Malay Islands. In consequence various commodities came to be known to the Indians, Egyptians, Greeks, etc., at earlier dates than might be otherwise easily accounted for, and moreover were sometimes spoken of as Chinese, Indian, Ethiopian, Arabian, etc., in consequence of the nationality of the traders, rather than the countries of supply. Hence very possibly the statement of Paulus Ægineta (and of most of the early writers) that cloves "were brought from India." As a matter of fact the clove even down to the present day can hardly be said to be systematically cultivated anywhere in India. Marco Polo (*Travels*, 1290 (ed. Yule), ii., 217) speaks of the cloves of Java, but his observation must be interpreted to denote the extensive traffic that even in his time had been established, since the clove did not then grow in that island. Barbosa (*Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 184, 219–20) visited Malabar and the "spice isles," and wrote, "The clove grows in the islands called Molucche, and from these it is brought to Malacca and thence to Calicut, a country of Malabar." So again, speaking of Pegu, he remarks there is much trade in cloves and mace and other Chinese goods. Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 245) also visited the Moluccas and gives a detailed description of the clove. Pigafetta investigated the clove plantations of Molucca in 1512, and wrote a full account of the methods of cultivation and manufacture of the spice. Garcia de Orta, who was in India from about 1535, and published at Goa in 1563 his *Colloquios dos Simples, etc.*, says (*Coll.*, xxv.) that the possession of the Molucca Islands (and thus of the clove and nutmeg trade) was the cause of the war between the Spanish and the Portuguese. But it would be absurd to believe that cloves were not known prior to the discovery of the Moluccas. The price of cloves is stated in the *Ain-i-Akbari*, a work written in Agra (1590), so that they were by then regularly known and traded in all over India (Blochmann, transl., 64). Linschoten gives an exhaustive account of the spice about the same date, and Pyrard (1601) also described it. In 1603 the East India

Company were trading in cloves (Birdwood and Foster, *E.I.C. First Letter Book*, 36), and a little later we read of the cultivation being rapidly extended all over the tropics. Rheede does not, however, apparently describe the plant, so that very possibly it was not being cultivated in India during 1686—the date of his great work—the *Hortus Malabaricus*. About that time, however, the spice was an important article of trade with India. Tavernier (*Travels Ind.*, 1676 (ed. Ball), ii., 17), for example, discusses the Dutch monopoly and the clove traffic of Surat. [*Cf.* Acosta, *Tract. de las Drogas*, 1578, 30–4; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 109.]

Ambo Name

Rumphius figures and describes the clove plant (*Herb. Amb.*, 1750, ii., 1–5, t. 1), and gives a long list of its vernacular names. He lived and died in Amboyna and was, in all probability, familiar with every aspect of the clove plant and trade. The Chinese, he says, called it *thenghio* (= sweet-smelling nails); the modern Malay name is *tsjancke* and the old Malay name *bugulawan*; in Amboyna it is *buhulawan*; in Ternate *boholawa*, and in Tidora *gomode*. Filet (*Plantkundig Woordenboek*) gives it the name *bobolawa*. Crawfurd (*l.c.* 101) says, "It is very difficult to understand how the clove could have come first to be used as a condiment by foreign nations, considering the well-ascertained fact that it has never been used as such, and indeed hardly in any other way, by the inhabitants of the countries which produce it." He then proceeds to explain that the earliest names in the Moluccas for the clove are connected with the foreigners who came to their shores to procure the spice. The most frequent name, he says, is *cangkek*, which has not the sound of a native word, but is a corruption of the Chinese *tkeng-hia*. There seems no doubt the Chinese procured the clove from its island home for several centuries before it had reached Europe. There are records that point to this traffic as early as 260 B.C. Crawfurd, however, mentions none of the names given by Rumphius, but if these be actually the local names of the tree they have not apparently accompanied the clove into the commerce of the world. Little astonishment need, however, be expressed at these names not having accompanied the clove, when it is recollected that it was not regarded by the inhabitants of the "spice islands" as of any value until the Chinese desired to be supplied with the "little sweet-scented nails." In that circumstance alone lay the interest taken by the people of Moluccas in the plant, and "nail" or "clove" became its name in most countries.

Chinese Name

Migration.

Sonnerat (*Voy. Nouv. Guin.*, 1776, 195, tt. 119–20) tells us that he found the clove being grown in New Guinea, and it is well known that in 1770 M. Poivre, of the Isle of Bourbon, sent M. Provost to Ceram in order to procure live plants of both the clove and the nutmeg. This enterprise was completely successful, and shortly after the plants flourished so well in their new home that seedlings were sent to Cayenne about 1784, and in an incredibly short time the plantations were extended and cloves regularly sent into market of such quality that they were pronounced equal, if not superior to those of the "spice islands." Very shortly after the date mentioned the clove was carried to the West Indies (Dominica in 1789), in fact throughout the tropical world, and was even cultivated by Sir Joseph Banks at Kew in 1797. It had been successfully acclimatised in Zanzibar and Pemba. Migration became imperative, through the short-sighted policy of the Dutch, who sought to secure for themselves an absolute monopoly in the world's supply. For this purpose they ruthlessly destroyed the trees in all the islands except those specially set apart by themselves for clove-production. Having trampled on the rights of the people, retribution became a natural consequence. It is not much to be wondered at, therefore, that when in time a more liberal policy prevailed, the new countries of clove-production had so securely established their positions that a restoration or concentration of the traffic in the original home of the clove became an impossibility.

Retribution.

Cultivation.

Bud.

Cultivation.—Cloves are the dried unexpanded flower-buds of this tree. The corolla forms a ball on the top between the four teeth of the calyx, and the stalk is the immature ovary. They are at first green, then turn yellow, and finally bright pink or scarlet. In this last stage they are ready to be picked. If allowed to remain longer on the tree the flowers expand, become fertilised, and the stalk of the clove then develops into a succulent purple-coloured berry containing one or two seeds. This is known technically as the "mother clove." These are sown in

'Mother Clove.'

rich mould about 12 inches apart, and the fresher the better, since the seed when dried soon loses its vitality. They germinate within five weeks and when 4 feet high are transplanted from the nursery into their final positions, 20 to 30 feet apart. The soil must be porous, well-drained, and consist of mould with a fair proportion of sand. The plants will not thrive on clay nor pure sand, and marshy land is fatal. Even in the Malaya the clove tree does not luxuriate alike on all the localities on which grown, and seems to prefer a soil formed from volcanic rock (Crawfurd, *l.c.* 101). In Pemba the soil most suited is a dark loam, having underneath a layer of dusky yellow earth intermixed with gravel, also a yellowish or reddish stiff clay (*Kew Bull.*, 1893, 17–20). Although indigenous to islands it does not succeed well when exposed to the direct sea-breezes. It prefers confined valleys, though dense overhead shade is highly injurious. Protection from high winds is essential, and a tree hedge along the windward side of the plantation is very desirable. But in place of seed the plant may be raised by layering. Young branches laid across the ground take root in about six weeks. The young plants should be transplanted at the beginning of the rains. Shade is necessary for the first two or three years, and watering occasionally is advantageous during exceptionally dry weather, both before and after transplanting. By the end of the third year the shade should be removed, and by the sixth the plants will have come into bearing and be in full crop by the twelfth. By 20 to 25 years they are usually too old to be profitable, though they may yield up to 150 years. It is accordingly customary to renovate certain portions of the estate every 8 years. In the Moluccas the trees are topped at 8 or 9 feet, so as to secure low plants easy of being picked. Each tree should give about 6 to 7 lb. of dry cloves. The best course is to hand-pick the clusters of buds, but occasionally they are beaten off the trees and caught on cloths spread below, or the ground is swept clean, so as to allow of the cloves being picked up without being injured. Every third or sixth year a heavy crop is obtained, and now and again (especially if over-cropped or injured) the trees bear next to no flowers.

Raised in a Nursery.
Soil.
Volcanic Soil.
Confined Valleys.
Protection from Winds.
Layering.
Temporary Shade Necessary.
Duration.
Yield.

In the spice islands the cloves are sometimes cured by being smoked over a shallow wood fire, until they assume a deep brown colour, when the further drying is accomplished by the sun. Occasionally the buds are scalded in hot water before being dried. But if bright sunny days prevail artificial heat may be dispensed with and the buds sun-dried from first to last. The crop loses about 60 per cent. in drying.

Curing.
Sun-drying Preferable.

Nicholls (*Textbook Trop. Agri*, 1892, 184–9) gives useful particulars of clove cultivation. A most interesting and instructive account of the production, manufacture and trade in this spice was also written by Mr. J. C. Sawer in *The Produce World* (May 1896). Mr. R. N. Lyne of Dunga, Zanzibar, published a valuable report on the plantations of that island, now by far the most important single country of production. [*Cf. Trop. Agrist.*, July 1901, 11–2; *Der Tropenpflanzer; Journ. Soc. Chem. Indust.; Pharmaceut. Journ.; Chem. and Drugg.; Dipl. and Cons. Repts.;* etc.]

Useful Publications.

Uses.—It is needless to say that the clove, though not held in such high esteem as in former times, is still a spice of considerable commercial importance. Oil of Cloves will be found dealt with in great detail by Gildemeister and Hoffmann (*Volatile Oils*, 1900, 512–8). It would appear that it was first distilled in the 15th century. The cloves of Pemba are those chiefly used for this purpose. Those of Amboyna and

Oil.

Reunion are richer in oil, but command, as a spice, too high a price to be used in distillation. The most expensive clove is that of St. Marie in Madagascar. Clove-oil is largely employed in perfumery. Its value is estimated by its *eugenol* content, which varies from 76 to 85 per cent.

Trade. Exports. ***Trade.***—Zanzibar and Pemba yield four-fifths of the total clove-supply of the world. There is a small *EXPORT* of Indian-grown cloves from Madras, a circumstance that points to a certain amount of cultivation. The traffic is, moreover, an expanding one. In 1899-1900 these exports stood at 148 lb. ; in 1901-2 at 3,329 lb. ; in 1903–4 at 12,598 lb. ; in 1904-5 at 25,537 lb. ; in 1905–6 at 11,825 lb. ; and in 1906–7 at 5,173 lb. Imports. As compared with these records, the *IMPORTS* were 7,815,486 lb., valued at Rs. 17,63,050, in 1899-1900 ; 6,983,582 lb., valued at Rs. 15,33,174, in 1901-2 ; 6,659,913 lb., valued at Rs. 17,03,296, in 1903-4 ; 8,345,521 lb., valued at Rs. 22,01,424, in 1905–6 ; and 5,062,782 lb., valued at Rs. 16,28,355, in 1906-7. Practically the whole comes from British East Africa, and is received by the town of Bombay. There is an increasing trade from Germany (? Colonies), which supplied 1,100,068 lb. in 1905–6 and 798,851 lb. in 1906-7. The traffic with the Straits Settlements and China is insignificant—under 100,000 lb. from each taken by India. From the imports, however, are drawn the re-exports, viz. 1,000,000 lb., the major portion going to the Straits Settlements and China (Hongkong). India is thus once more a large emporium for the cheaper grades of clove, but in the opposite direction to its ancient traffic.

D.E.P., iii., 294-302. **EUPHORBIA,** *Linn.* : *Fl. Br. Ind.*, v., 244-66 ; Gamble, *Man. Ind. Timbs.*, 590-1 ; Brandis, *Ind. Trees*, 557-8 ; Prain, *Beng. Plants*, ii., 923-5. EUPHORBIACEÆ. This is a genus of herbaceous plants mostly, though a few assume the condition of useful hedge bushes or even small trees. There are in India some 53 species : 7 or 8 only are of economic value.

The English generic name Spurgewort denotes their chief medicinal property, but their greatest potentiality lies in the utilisation of their milky sap as a source of gutta-percha. It will be seen from the brief specific review that follows that this subject has engaged spasmodic attention in India for the past century or more without any practical results having been obtained. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 28–9) gives the results of his examination of the latex of two species. They yielded large quantities of euphorbium and resin to boiling alcohol. Many of the species are valued as manures in the reclamation of waste lands.

E. antiquorum, *Linn.*—A small tree of the dry regions of India generally. Is often used as a hedge plant, and best known by the following names:—*vajri* in Sanskrit, and in the vernaculars—*nara sij* or *narsej*, *tekátá sij*, *tidhára*, *shidu*, *kalli*, *bonta kalli*, *tazaung*, *pyathat*, etc. Fryer (*New Acc. E. Ind. and Pers.*, Hedge Pla 1672-81, 105) alludes to the ***Euphorbia*** hedges of the Deccan, which doubtless to some extent consisted of this species. In some parts of Eastern Bengal and Assam this tree is almost sacred, and is supposed to protect the gardens around which planted, and like ***E. neriifolia***, *Linn.*, has the merit, so it is thought, of safeguarding the inhabitants against snake-bite. Both are, in fact, sacred to *Mansá*, the goddess of serpents.

E. neriifolia, *Linn.*—A small tree wild on rocky situations in the Deccan, West Coast and Orissa, but often seen under cultivation, especially in Bengal. It is the *mansá sij*, *páta-sij*, *sehund*, *thor*, *nivarung*, *mingut*, *kalli*, *yellikalli*, *shazaung*. It has a more or less cylindrical stem (the allied form ***E. ligularia***, *Roxb.*, being four- or five-angled) with stipular thorns on numerous tubercles.

Medicine. The MILKY JUICE of this as also the foregoing species is used medicinally all over India ; it is purgative and rubefacient. Is a popular application to warts and other cutaneous affections. Internally the juice is usually administered along with other purgatives and aromatics. In the *Indian Forester* (1891, xvii., 350) Gleadow tells the results of some experiments he performed to extract the rubber contained in the present species. His samples were sent to Europe and reported on in such terms as to discourage further effort.

Unfavourable Report.

E. pilulifera, *Linn.*—A small herb found throughout the hotter parts of India from the Panjáb southwards. Is the *dudhi, dudeli, burakeru, pusitoa, gordon, nayeti,* etc. Used in the affections of children—bowel and lung complaints. A fluid extract has been employed in asthma and in dysentery (*Rept. Cent. Indig. Drug. Comm.*, i., 154).

E. Royleana, *Boiss.*—A large shrub common on dry rocky hillsides of the outer Himalaya from Kumaon westwards, and also in the Salt Range. It is a most conspicuous and characteristic plant in the tracts of country indicated. Its ascending fleshy branches (or stems) are five-angled and thorny. It is the *thor, shakar pitan, sali, chúla, chún, sura, tsui, suru, sihund,* etc. The milk contains a large amount of gutta-percha. When fresh it has a sweet odour and does not blister the fingers, but it is very injurious to the eyes and flavours anything handled even after the greatest care may have been taken to clean the fingers. Some few years ago a fairly extensive series of experiments were conducted with this milk, having in view its utilisation as a waterproofing material or as a paint for ships. The subject is alluded to because sufficient evidence was obtained to satisfy belief that (without contemplating the utilisation of the milk as a gutta-percha substitute or the establishment of factories beyond both the means and the capabilities of the inhabitants of the country where ***E. Royleana*** is an abundant and at present useless plant) there might still be directions in which it might be possible to convert the limitless supply into a source of wealth. (See **Gutta-percha**, p. 627.)

Gutta-percha.

Possible Utilisation.

E. Tirucalli, *Linn.*—The Milk-hedge or Milk-bush or *sehund, shir, shera, lanka sij, seju, nevli, nival, kadu-nevali, jemudu, thuvar, yele-gulla, tirukalli, sha-shoung,* etc. A small tree with round stems and smooth branches. It is generally believed to be a native of Africa, but has been for many years completely naturalised in India, especially in the drier tracts of Bengal, the Deccan, South India and Ceylon. Heyne (*Tracts, Hist. and Stat. Ind.*, 1814, 243) discusses fully the possibility of utilising the milk of this and other Euphorbias. Drs. Riddle, Cheek and Falconer devoted much time and attention to the self-same subject about 1850. It was observed that after boiling, the milk of this species becomes brittle, though whilst warm it is ductile and elastic. Giberne (*Ind. For.*, 1899, xxv., 84-5) has urged the desirability of the milk of this and other species of ***Euphorbia*** being put to some useful purpose. He found that nitric acid caused the separation of the rubber. Mixed with mud the milk is employed in North Arcot in the construction of the flat roofs of houses. It is, in Ganjam, said to be used to intoxicate and poison crows: for this purpose a little is mixed with boiled rice and given to these birds. The acrid juice is in India generally, well known as a purgative and counter-irritant (especially in the treatment of animals), and it is so very painful when applied to wounds or to the eye that cattle are fully aware of this fact and will not attempt to break down a hedge of it. (Consult the controversy regarding **Angola (Almeidina) Rubber**—***E. rhipsaloides*** *versus* ***Tirucalli.***)

Possible Useful Milk.

Waterproofing Houses.

Purgative.

EXCŒCARIA AGALLOCHA, *Linn.*; *Fl. Br. Ind.*, v., 472; Roxb., *Fl. Ind.*, iii., 756–7; Gamble, *Man. Ind. Timbs.*, 626; Brandis, *Ind. Trees*, 585; Prain, *Beng. Plants*, ii., 955; EUPHORBIACEÆ. The Blinding Tree, *gangwa, geor, geria, uguru, gnua, phungali, geva, thillaymaram, tilli, chilla, tella-chettu, haro, kaduva-pal, tayau, yekin, tella kwiya.* It may be the *taggar* wood of Sylhet alluded to under **Aquilaria** (p. 74). A small evergreen tree of the coast and tidal forests of both sides of the Indian Peninsula, Burma, the Andaman Islands and Ceylon.

D.E.P., iii., 306–7.
Blinding Tree.

The wood contains a milky juice which hardens on exposure to the air into a black caoutchouc-like substance. The sap which exudes from the fresh-cut bark is very acrid, some say poisonous, hence the name Blinding Tree or *arbor excœans* (Rumph., *Herb. Amb.*, ii., tt. 79–80). Hooper (*Yearbook of Pharmacy*, 1899, 468) gives an account of the chemistry of this latex, which he analysed with a view to ascertaining its value as a rubber. The TIMBER is useful for general carpentry purposes and for match-making. [*Cf. Pharmacog. Ind.*, iii., 1893, 314–5; *Ind. For.*, 1897, xxiii., 150.]

Gum.

Rubber.

Timber.

D.E.P.,
iii. 310–11.

Temperate.

Alpine.

FAGOPYRUM, *Gaertn.* : *Fl. Br. Ind.*, v., 54–5; POLYGONACEÆ.

F. esculentum, *Moench*; Duthie and Fuller, *Field and Garden Crops*, 1893, pt. iii., 25, t. 83; *Rec. Bot. Surv. Ind.*, i., 33, 40, 219, 262; Woodrow, *Gard. in Ind.*, 1899, 430; Mukerji, *Handbook Ind. Agri.*, 1901, 56, 260. This is best known as Buckwheat or Brank, *phaphra, kotu, kúltú, rajgir, doron, ugla, ogal, bares katú, bres, trúmba* (*tramba*), etc. Extensively cultivated on the temperate Himalaya and lower hills of India, from Afghanistan and Kashmir to Darjeeling, Assam and Burma. There are many cultivated states, some grown for the grain, others as a vegetable, and these blend imperceptibly into the wild ***F. cymosum***, *Meissn.*

F. tataricum. *Gaertn.*; Duthie and Fuller, *l.c.* 26–8, tt. 84, 96. This is the *kaspat, kala trúmba* (black *trumba*), *chin, karmabres, ugal, káthú, tráo rjás*, etc. It is usually known as Black Buckwheat, but as a rule *phaphra* denotes ***F. esculentum***, and *ugal*, ***F. tataricum***. This form is cultivated throughout the higher temperate Himalaya, especially on the western extremity between altitudes of 9,000 and 15,000 feet. It is a taller, coarser plant than the other species, having longer grains (nuts, as they are sometimes called) of a black colour, and with the angles rounded off and keeled toward the top, instead of being sharp. There are many cultivated forms, one from Kangra having been treated as a distinct variety under the name ***himalaica***.

Cultivation.
Seasons.
Lower Hills.

Plains—a Vegetable.

Higher Reaches Grain Crop.

Catch Crop.

Chief Food-grain.

On the lower Himalaya, between 4,000 and 10,000 feet, ***F. esculentum*** is grown, being sown in July and reaped in October. In the lower reaches of its mountainous area it is usually raised more as a vegetable than a grain. Indeed in Northern and Eastern Bengal, Assam and Burma (and even in the Deccan, the Central Provinces and Bihar) it is often met with (on the plains) as a catch or garden crop, where it is exclusively used as a vegetable or fodder. Of the mountains of Assam, Manipur and Burma, it might be said that a climatic depression exists which admits of plants being grown two or three thousand feet below their normal habitats. Hence in these regions the grain-yielding buckwheat becomes an important article of food at altitudes even below 5,000 feet. In the higher reaches of its area buckwheat often becomes exceedingly important, more especially ***F. tataricum***, which, following the spring barley or wheat, is sown in July and gives a supplementary crop before the early snowfall puts a stop to agricultural operations. It is frequently utilised as a first crop on new clearances, and in the most alpine tracts sheltered portions of the grassy slopes are utilised in giving a catch crop one year and left fallow for several succeeding years. It may also be grown on soils too poor for wheat and barley. It seems to succeed fairly well on rocky soils containing a high percentage of granitic detritus, but not on clay. Lawrence (*Valley of Kashmir*, 1895, 338) informs us that buckwheat (both species) can be grown late on almost any soil, and that in the higher villages ***F. tataricum*** constitutes almost the only food-grain of the people. In the lower valleys, he adds, irrigation is sometimes given. Mukerji urges the claims of buckwheat as a catch crop; it yields a return in ten weeks after sowing; it can be grown on poor soils and is able to withstand a greater extreme in heat and cold than can be said of any other known crop.

Bread.

Spinach.

As a human food buckwheat does not hold a high place, since about 20 per cent. of the weight is lost in decortication. The nuts are husked and ground into flour, which is made into bread or eaten as porridge. The leaves and shoots are boiled as a spinach. For poultry and horses, however, the unhusked nuts are regarded as very superior, while the straw is more nutritious than that of cereal. ***F. tataricum***, *var.* ***himalaica***, is a better food than ***F. esculentum***, as it is richer in oil and contains less indigestible fibre.

[*Cf. Kew. Bull.*, 1893, 3; McHutchin, *Assess. Rept., Kashmir*, 1894, ii., 5–14; Barclay, *Agri. Ledg.*, 1895, No. 20, 366–7; Diack, *Settl. Kullu*, 1898, 8–10; Watt, *Agri., Ledg.*, 1898, No. 15, 515; Thorpe, *Dict. Appl. Chem.*, 1898, i., 388; Church, *Food-Grains of Ind.*, 1901 (suppl.), 9–10; Rawson, Gardner and Laycock, *Dict. Dyes, etc.*, 1901, 70; Leach, *Food Inspect. and Anal.*, 1905, 213, 239–40.]

D.E.P. iii., 328–39. Asafetida.

FERULA, *Linn.*; *Fl. Br. Ind.*, ii., 707–8; Aitchison, *Trans. Linn. Soc.* (2nd. ser.), iii., 67–9. A genus of umbelliferous herbs which contains some sixty species found in Europe, North Africa and Central Asia. They grow from perennial root stocks, and some attain annually a height of from 8 to 10 feet. They afford the various forms of Asafetida, Galbanum, Sambul, etc.

History.—The *silphion* of the early Greek writers was an edible product derived very possibly from a species of ***Ferula***. but was not *asafetida* as accepted in modern commerce. The *laser* (*laserpitium*) of later writers, on the other hand, was very possibly the medicinal drug of the present day. Though botanically quite distinct, the edible *silphion* is strongly suggestive of the edible *hing* of modern Indian commerce. [*Cf.* Oersted, *Silphium of the Ancients*, in *Journ. Bot.*, 1873, ii., n.s., 176–9.] Theophrastus (*Hist. Pl.*, vi., ch. 3 (ed. Scaliger), 1644, 598–9) speaks of two varieties, one coming from the stem, the other from the root. Dioscorides mentions two kinds, one obtained from Cyrene, the other from Asia. Strabo contrasts the Asiatic gum with that known in Europe. Plautus (220 B.C.) makes frequent mention of *laser*, and Galen, Ætius, Oribasius and Paulus Ægineta all deal with its medicinal virtues. Celsus gives an interesting description, and Pliny bases his encomium on the account furnished by Dioscorides, but he lays special stress on the fact that *silphion* had disappeared and its place been taken by the much inferior *laser* of Persia. By Sanskrit medical authors the gum is *hingu* and the plant *jatuka*; by Arabic writers it is *asa* or *hiltut*, and by Persian *anguzan*. But so far as can be learned there is no classic mention of the distinction between *hing* and *hingra*. References to the medicinal uses of the drug (*hingu* or *himgu*) will be found in *The Bower Manuscript* (5th century A.D.) (Hoernle, transl., 1893–7, 81, 85, 86, 180, etc).

Arab Writers.

Myropsicus was apparently the first writer who combined the Arab name *asa* with the descriptive word *fetida*, a new name, he tells us, used by the Italians. Ibn Sina (Avicenna), a Muhammadan, who lived in the 10th century, mentions two kinds of *asa*, viz. *tyib* (good) and *muntin* (fetid), while Ali Istakhri, who also lived about the same time, states that the drug was produced in the desert between Seistan and Makran. The geographer Edrisi, who wrote about the middle of the 12th century, says that asafetida was collected largely in Western Afghanistan. It is perhaps significant that Marco Polo, who marched (1290) through a great portion of the country where certain grades of this drug are produced, should make no reference to it. Garcia de Orta (1563, *Coll.*, vii.; also Ball, Comment., *Proc. Roy. Ir. Acad.*, 1889–91, 393) mentions that it was reported to reach India from Khorasan through Hormuz, but was also grown in Gujarat, and from Dely, a land bordering on Khorasan and Chiman. Acosta (*Tract. de las Drogas*, 1578, 362) gives many interesting particulars of the drug imported into India. Jacobus Bontius (*Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 41) relates that the plant from which asafetida is produced grows in Persia, between the States of Lara and Gamaron. Mandelslo (*Travels*, 1638, in Olearius, *Hist. Muscovy, etc.*, 84) furnishes a similar account. Bontius also states that by the Javans and the Malays and other inhabitants of India it is called *hin*. Fryer (*New Acc. E. Ind. and Pers.*, 1675, 239) intimates that asafetida is gathered at a place called Descoon, and says it differs from the stuff the Indians call *hing*, which comes from the province of Carmania.

Accounts of Indian Travellers.

Asafetida Biscuits.

Hing and *Hingra.*

No satisfactory account of the plant yielding asafetida was given till 1712 (Kæmpfer, *Amœn. Exot.*, 537 and pl.). Hove (*Tours in Gujarat, etc.*, 1855, 133), who visited Bombay in 1787, describes the cakes flavoured with asafetida that he was given to eat. He also says there are two kinds—*hing* and *hingra*. Milburn (*Or. Comm.*, 1813, i., 133) gives a description of the commercial drug of his day, and states that it had been in use nearly 1,000 years. But he was in error when he supposed this to be the true asafetida plant. Aitchison, who travelled in Eastern Persia, Baluchistan and Afghanistan (with the Afghan Boundary Delimitation Commission of 1884–5) elucidated this obscure subject very largely.

He found the word *kema* generic, the asafetida plant being *anguza-kema*, and Ammoniacum *kandal-kema*. [*Cf.* Stapf, *Kew Bull.*, 1907, 375–88.] Commenting on this view, the authors of the *Pharmacographia Indica* (ii., 143) observe, "It would appear then that the kind of asafœtida called *tyib* by the Arabs and their followers is the drug of European commerce, the produce of ***Ferula fœtida***, *Regel*, and not that of ***F. alliacea***, *Boiss.*, which produces the *hing* of India." Holmes in the *Pharmaceutical Journal* (3rd ser., xix., 21–34, 41–4, 365–8), and the various Museum Catalogues of the Phamaceutical Society of Great Britain, has afforded many useful particulars and focussed the practical results of recent research. A long account of the philology of the word "asafœtida" is given by Prof. J. Attfield (*Yearbook of Pharmacy*, 1897, 351–6), who, after consulting Dr. Murray (editor of the *Oxford Dictionary*), had come to the conclusion that it should, both in English and Latin, be rendered "asafetida." When discussing the *hing* and *hingra*, it seems probable that it would be more correct to assign these to groups of species rather than to say that they were each the product of one species. Indeed it would appear that the part of the plant from whence procured, the season of the year when collected, the methods of preparation and degrees and materials of adulteration, exercise considerable influence on the quality and flavour of the resulting drugs. It is, however, convenient to group the commercial resinous products of ***Ferula*** under three chief species :—

F. alliacea, *Boiss.*; Bentley and Trimen, *Med. Pl.*, 1880, ii., 126; Dymock, *Mat. Med. W. Ind.*, 1885, 381. In Khorasan it is called *angusheh*, in Kirman, *zendebuj*, while it is also known by the following names—*hing*, *anjudán*, *vagárni*, *abhushaharu hing*, *káyam*, *perun gayam*, *ingura*, *anguza*, etc. A herb which grows to a height of 2 to 4 feet. It is found wild (is not, at all events, cultivated) in Eastern Persia in the neighbourhood of Djendack and Yezd, and in Khorasan near Seharud, Nischapur, Meshed, Dehrachtindjan and Kerman. It prefers a stony, arid soil, and is found at an altitude of 7,000 feet. This plant is the chief source of the asafetida used in India and known as *hing* (which means pure or superior *hingra*), while that of European commerce is the product mostly of ***F. fœtida***—*hingra*.

Gum-resin. Hing. This might be spoken of as the edible form. The GUM-RESIN is obtained by wounding the upper part of the root, from which a small quantity of a fine gum escapes and is collected. The living root is then sliced daily, or every two or three days, with the exudation adhering to it, till exhausted. The whole mass, consisting of alternate layers of root and gum-resin, is then packed in a skin. As found in the market, the resin consists of a blackish-brown, brittle mass of extremely fetid odour, unadulterated with earth or gypsum, but always with slices of the root. In Bombay it is sometimes adulterated by the addition of gum-arabic, and the cheaper sorts contain an undue proportion of root. Adulteration with sliced potato also takes place.

Chemistry and Medicine. The resinous mass contains an abundant essential oil which differs from that of *hingra* in having a reddish hue, a higher specific gravity, and a stronger rotatory power. An alcoholic tincture is not precipitated by acetate of lead, nor is the sulphuric-acid solution fluorescent. From earliest times the gum has been held in esteem by Eastern doctors. It is a carminative and antispasmodic, and taken daily is said to ward off malarial fever. It is also recommended as a vermifuge. [*Cf. Pharmacog. Ind.*, 1890, ii., 141–7; Kanny Lall Dey, *Indig. Drugs Ind.*, 1896, 127–8; Thorpe, *Dict. Appl. Chem.*, 1898, ii., 273.]

F. fœtida, *Regel*; Drude, in Engler and Prantl, *Pflanzenfam.*, iii., 231; *Kew Mus. Guide*, 1907, No. 1, 115; *hingra*, *anguza-kema*, *kurne-kema*, *khora-kema*, *vaghayani*, *hingu*, etc. A herb with a circular mass of foliage, springing annually from a perennial root stock. It grows in Southern Turkestan, Persia and Afghanistan. This would appear to have been the Persian plant sent by Dr. Guthrie of Edinburgh, and grown in the Botanic Gardens there in 1780. [*Cf. Phil. Trans.*, 1785, lxxv., 36.]

Gum-resin.—This is the European drug of commerce, and is obtained from Laristan in Persia and from Herat in Afghanistan. It is collected in June, Collection.

the method pursued being briefly as follows:—The tap-roots are exposed for a couple of inches. A thick slice is cut from the top, from which a quantity of milk exudes. The root is then protected from the sun by a domed structure, 6 to 8 inches in height, called a *khora*, formed of twigs and clay and which has an opening towards the north. In five or six weeks' time a thick, gummy, reddish substance appears in irregular lumps on the exposed substance of the root. This is scraped off or removed along with a slice of the root, and placed in a leather bag. It was reported that the plants were sometimes operated upon more than once during the season. The gum is next carried to Herat, where it is deliberately adulterated. [*Cf.* Aitchison, *Pharm. Journ. and Trans.*, Dec. 11, 1886.] Masson (*Journ. Kalat*, 1848, 451–3) speaks of the plant as flourishing in Seistan, the gum being collected as *nushki*. Bellew, in his account, says that after cutting the plant through, above the root, three or four incisions are made in the stump, and the operation of incision is repeated every three or four days, so long as sap continues to exude. A particular sort is mentioned by the same writer as being obtained solely from the node or leaf-bud in the centre of the newly sprouting plant. This kind is never adulterated, and may be the fine quality of the drug known as *Khandahari-hing* (*Pharmacog. Ind.*, ii., 151). The common form is much adulterated by a kind of red clay (*tawah*), by wheat or barley flour, and by powdered gypsum. It is also mixed with slices of the root. All species of the drug have a powerful, garlic odour, and a bitter acrid taste. Except *Khandahari-hing*, this variety of asafetida is not used in India.

Adulteration.

Maynard and Prain, on the Botany of Baluch-Afghan Boundary Commission of 1896 (*Rec. Bot. Surv. Ind.*, i., 130–1), furnish interesting details of the collections of the commercial article on the hills between Samuli and Robat. Asafetida, they observe, affects bare rocky hillsides. It is the plant, or at least one of the plants, that people from Kandahar yearly visit the Koh-i-Sultan to collect. Sir Arthur H. McMahon described the collection of the gum from personal observation. The heads are cut down to within one or two inches of the ground. The cut ends are then covered with a little dry earth in order, the collectors say, to keep the wind off. After twenty hours the people collect what has exuded and cut the stalk down another eighth of an inch. But the milk is not allowed to dry in the sun; to obviate this the collectors build small stone traps, open at one side, over each plant, in order to keep off the sun's rays. The juice when partly dried is mixed with some kind of earth, like fuller's-earth; this is merely to increase the weight, and not with any idea of improving the quality. Doubtless the precautions taken to prevent drying are mainly with a view to facilitate this subsequent adulteration.

Method of Collection.

Medicine.

Asafetida consists of resin, gum and essential oil in varying proportions, but the resin generally amounts to more than one-half. It is partly soluble in ether or chloroform. The oil may be separated by distillation. It is light-yellow, with a pungent odour, and if exposed to the air evolves sulphuretted hydrogen. An alcoholic tincture of the drug is precipitated by acetate of lead, and a solution in sulphuric acid is fluorescent. Medicinally it is used in Europe as an antispasmodic and stimulant (see **Vinegar**, p. 1110).

According to Bellew, Masson and Aitchison, the Natives of Bokhara employ the leaves as a green vegetable, while the white underpart of the stem of the full-grown plant is considered a delicacy when roasted and flavoured with salt and butter. [*Cf.* Borszczow, *Ferulaceen*, 1860, 3–26; *Pharmacog. Ind.*, 1890, ii., 147–52; *Gard. Chron.*, 1896, 330–1; Thorpe, *Dict. Appl. Chem.*, 1898, ii., 273; Dutt, *Mat. Med. Hind.*, 1900, 175–6; White and Humphrey, *Pharmacop.*, 1904, 82–3; Tschirch, *Die Harze und die Harzbehälter*, 1906, i., 360–76.]

F. galbaniflua, *Boiss. & Buhse.*—This is the chief source of the drug known as Galbanum; *bireja, ganda-biroza, badra-kêma, barzed.* It is a native of Persia (especially Shiraz and Kirman), from which the gum is imported into Bombay and re-exported to Egypt and Turkey. Around Gulran it is reported to be specially common.

Gum-resin.

Gum-resin.—There are three kinds known in commerce: Levant, Persian, Solid, and Persian Liquid. The first comes from Shiraz, and is known as *khassnib;* the second has an odour of turpentine, and the third is the *gao-shir* or *jawáshir*. As met with in India, *gao* (*jao*)-*shir* is a yellow or greenish semi-fluid resin, generally mixed with the stems, flowers and fruits of the plant. It is obtained from the stem, which, when injured, yields an orange-yellow gummy fluid. Generally, however, the galbanum of commerce forms round, agglutinated tears, about the size of peas, orange-brown outside, yellowish-white or bluish-green inside. The odour is not disagreeable like that of asafetida, and the taste is bitter.

Medicine. Galbanum consists essentially of about 65 per cent. resin, 20 per cent. gum, 3 to 7 per cent. volatile oil. The oil is obtained by distillation with water or by extraction with petroleum ether. In medicine, galbanum is administered internally as an expectorant, and externally it enters into the composition of plasters. [*Cf.* Cooke, *Rept. Gums, Resins, etc., in Ind.*, 1874, 60–1 ; Bentley and Trimen, *Med. Pl.*, 1880, ii., 128 ; *Pharmacog. Ind.*, ii., 152–6 ; Thorpe, *Dict. Appl. Chem.*, 1898, ii., 274 ; Schimmel & Co., *Semi-Ann. Rept. April–May*, 1901, 36 ; *Chem. and Drugg.*, 1901, lix., 374–5 ; Tschirch, *l.c.* 346–58.]

F. Narthex, *Boiss.*; *Narthex asafœtida*, Falconer, *Trans. Linn. Soc.*, 1846, xx., pt. i., 285–91 ; Balfour, *Trans. Roy. Soc. Edinb.*, xxii., pt. ii., 261–8, pl. 20–1. This plant owes its discovery to Falconer, who found it in 1838 in Western Tibet on the slopes of the mountains dividing that country from Kashmir. From the plants thus collected seeds were sent to the Edinburgh Botanic Gardens and thence distributed all over Europe.

Holmes mentions that in a letter Aitchison reports that he had come on ***F. Narthex*** at the very locality where he believed Falconer originally found it. He also says that Sir W. R. Lawrence, during his official tour through Jammu and Kashmir in 1893, saw the plant in flower between Astor and twenty miles north, near Doian. This plant was at one time accredited as the source of Tibetan asafetida, but as already mentioned the European drug comes from Persia and may be accepted as the produce of ***F. fœtida*** and the Indian of ***F. alliacea.*** [*Cf. Rec. Bot. Surv. Ind.*, i., 40 ; Holmes, *l.c.* Aug. 1894, 131 ; *Kew Bull.*, March 1895, 57 ; *Chem. and Drugg.*, 1901, lix., 374–5.]

Imports. ***Trade in Asafetida.***—The following figures are returned as the Trans-frontier imports of asafetida into British India from Afghanistan, Seistan, etc., for the years 1902–7 :—1902–3, 1,368 cwt., Rs. 1,73,760 ; 1903–4, 2,055 cwt., Rs. 2,63,891 ; 1904–5, 2,036 cwt., Rs. 2,58,762 ; 1905–6, 1,106 cwt., Rs. 1,38,901 ; 1906–7, 1,820 cwt., Rs. 1,59,873. During the years 1903–4 the IMPORTS by sea were 13,343 cwt., valued at Rs. 4,89,538 ; and in 1906–7, 6,062 cwt., valued at Rs. 2,42,635. Practically the whole of the foreign imports came from Persia and went to Bombay.

Exports. The EXPORTS are returned both as foreign re-exports and as Indian produce. The latter of course means asafetida brought to India by land routes. Of the foreign produce, 1,612 cwt. were exported in 1903–4, valued at Rs. 53,440 ; and 1,250 cwt., valued at Rs. 39,758, in 1906–7. Practically the whole went from Bombay. Of the so-called Indian produce, 332 cwt., valued at Rs. 13,548, were exported in 1903–4, but sank to 51 cwt., valued at Rs. 2,043, in 1906–7. The export figures should, however, be regarded as having reference to *hingra*, while the returns of imports are both *hingra* and *hing*. [*Cf. Brit. and Colon. Drugg.*, 1905, xlvii., 96, 120, 479, 504.]

D.E.P., iii., 342–62. **FICUS,** *Linn.* : King, *Ann. Roy. Bot. Gard. Calc.*, 1888, i., tt. 1–232 ; *Fl. Br. Ind.*, v., 494–537 ; Talbot, *List Trees, etc.*, 324–31 ; Gamble, *Man. Ind. Timbs.*, 636–51 ; Prain, *Beng. Plants*, ii., 971–83 ; Cooke, *Fl. Pres. Bomb.*, ii., 613–55 ; Brandis, *Ind. Trees*, 1906, 598–610 ; URTICACEÆ. A genus of trees, shrubs or climbers, sometimes epiphytic, which contains about 600 species. Most are tropical, and, according to Hooker, 112 are Indian. They have a milky sap which contains caoutchouc, and *F. elastica* is one of the chief sources of the India-rubber of commerce.

Banyan Tree. **F. bengalensis,** *Linn.* ; Woodrow, *Man. Gard. in Ind.*, 1899, 453 ; *Ind. Gard.*, Jan. 4, 1900, 3 ; *Rec. Bot. Surv. Ind.*, iii., 102 ; 1905, 279. The

Banyan Tree, *bor, bar, bargat, but, bai, ranket, kangji, barelli, wóra, kurku, baagat, phagwari, wur, wad, ala, mari, ahlada, gilike mara, peralu, pyi-nyoung, maha-nuga, vata*, etc. A large tree which throws down numerous aerial roots from the branches. It is found in the Sub-Himalayan forests from Peshawar to Assam; in the deciduous forests of Bihar, Chota Nagpur, Orissa, Circars, Central Provinces, Bombay Presidency and South India; less commonly in evergreen forests and in the low country of Ceylon. It is wild, but doubtfully indigenous, and is also largely planted throughout India for its shade. *Indian Gardening* gives an account of the famous specimen in the Botanic Gardens, Calcutta; described also by Sir George King (1895) in the *Guide* to these Gardens.

Rubber.
Bird-lime.
Fibre.
Medicine.

It yields an inferior RUBBER. According to Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 25), the latex contains only 12·4 per cent. of caoutchouc and 82·2 per cent. resin. Is employed in Lahore in the oxidation of copper. As a MEDICINE the juice is applied externally for pains and bruises, and used as an anodyne in rheumatism. An infusion of the bark is regarded as a powerful tonic in the treatment of diabetes. The leaves are heated and used as a poultice. The fruits ripen from March to June, according to locality, and are eaten in times of famine; it would moreover appear, in addition, that in many parts of the country the young tender shoots and leaves, as also the bark, are eaten. [*Agri. Ledg.*, 1904, No. 4.] The twigs and leaves are grazed as FODDER by cattle and elephants. The WOOD is of little value, but is durable under water and, therefore, utilised for well-curbs. If carefully cut and seasoned it can be made into furniture, and is sometimes employed for boxes and door-panels. The wood of the aerial roots is used for tent-poles, cart-yokes and banghy-poles. The banyan is one of the numerous hosts of the LAC insect. By the Hindus it is regarded as sacred, and plays a great part in connection with their religious ceremonies. [*Cf.* Pliny (Holland, transl.), i., 360; Linschoten, *Voy. E. Ind.* (ed. Hakl. Soc.), ii., 53–8; Pyrard, *Voy. E. Ind., etc.*, 1601 (ed. Hakl. Soc.), ii., 370, etc.; Tavernier, *Travels Ind.* (ed. Ball), ii., 198; Fryer, *New Acc. E. Ind. and Pers.*, 1672–81, 105; Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 163–4; *Hobson-Jobson* (ed. Crooke), 65–7; *Pharmacog. Ind.*, 1893, iii., 338; *Yearbook of Pharmacy*, 1899, 466–7; *Agri. Ledg.*, 1901, No. 9, 212, 235, 263; 1902, No. 1, 53; Joret, *Les Pl. dans L'Antiq., etc.*, 1904, ii., 291–2; Workman, *Through Town and Jungle*, 1904, 39–40; Dunstan, *Imp. Inst. Tech. Repts.* (*on latices of F. comosa and F. indica*), July 13, 1905; Cunningham, *Plagues and Pleasures of Life in Beng.*, 1907, 55–86, 339, 358–60.]

Food.
Fodder.
Timber.
Lac.

Edible Fig.

F. Carica, *Linn.*; *Rec. Bot. Surv. Ind.*, i., 136; Woodrow, *Gard. in Ind.*, 1899, 451–3; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 211–3. This species is the Edible Fig of Europe, the Smyrna Fig, also *anjir, kimri, fagu, fagári, shimai-atti, tiethie, ten*. Several varieties are cultivated in many parts of India, especially in Baluchistan, Afghanistan and Kashmir.

Cultivation.

A rich and mouldy soil is required with a considerable quantity of lime combined with thorough drainage. The trees are propagated by cuttings, of one-year-old wood, planted in shady beds in February. There should be about 10 to 12 feet between each root. As a fertiliser about 50 lb. of well-decayed village sweepings may be applied to each tree after the crop is gathered. The plant begins to bear FRUIT in the second or third year after transplantation and continues for twelve to fifteen years. It fruits twice a year. The first season commences in June–July, but it is not allowed to ripen lest it should injure the second crop, which commences in January and is by far the most valuable. Figs for drying should be cut from the tree and carefully placed in trays and boxes. To improve the colour and soften the skin, the figs, before drying, are sometimes exposed to the fumes of burning sulphur or are dipped in a hot solution of salt, saltpetre or lye; but the former practice gives the fruit a very unpleasant taste and is injurious to the health of the consumer. The drying ground should be a clean space outside the orchard where the figs may be exposed to the full rays of the sun. The figs should be turned twice a day at first, and once a day in the later stages. Drying within six or seven days yields the best quality. So far as India

Edible Fruit.

Medicine.

is concerned it would appear that the most approved variety is that found at the village of Khed Shivápur, 14 miles south of Poona at an altitude of about 2,200 feet, but the fruit of Baluchistan, Afghanistan and Persia is superior to the Indian. As a MEDICINE, the dried fruit is demulcent, emollient, nutritive and laxative. [*Cf. Pharmacog. Ind.*, 1893, iii., 342–5; Eisen, *Handling and Curing of Figs*, in *Ind. Agri.*, Nov. 1, 1897, 348; April 1897, 128; Feb. 1, 1898, 57; Dutt, *Mat. Med. Hind.*, 1900, 291; *Repts. Agri. Exp. Stat. California*, 1894, 1896 8, 1900, 1903 4; *Cyprus Journ*, 1905, ii., 76.]

Lac.
Fibre.

F. Cunia, *Ham.*; *Rec. Bot. Surv. Ind.*, ii., 65, 139; iii., 103; *Agri. Ledg.*, 1904, No. 4, 27–8. The *khewnau, dumbur, riu, kanhya, sangji kanai, poroh, ye-kha-ong, jonua*, etc. A moderate-sized tree of the Sub-Himalayan tract from the Chenab eastwards ascending to 4,000 feet, Bengal, Orissa, the Circars and Burma, usually on the banks of streams or in ravines. LAC is produced on this tree. A fibre is obtained from the bark which is used for tying the rafters of Native houses. The fruit ripens about July to October and is eaten in India, though somewhat insipid. The wood is not used economically. The leaves are rough and sometimes employed in place of sandpaper.

F. elastica, *Roxb.*; see **India-rubber** (pp. 651–5).

F. glomerata, *Roxb.*; *Rec. Bot. Surv. Ind.*, ii., 139, 188; iii., 103. The *gúlar, aroa tue, jagya dumar, dumer, lowa, dimeri, tchongtay, thoja, panwa, krumbal, batbar, dadhuri, umbar, ormul, rumadi, atti, moydi, kullakith, yetha-pan, udumbara*, etc. A large tree noticeable from its being deciduous in the middle of the rainy season. It is found on the Salt Range, the outer Himalaya and Sub-Himalayan tract from Kashmir eastwards; in Assam, on the Khasia hills and in Bengal; in Burma, Central, Western and Southern India, and in Ceylon.

Gum.
Fruit.
Timber.
Dye.

It produces a viscid GUM which is made into birdlime; Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1906–7, 6) mentions that the latex contains only 4·9 per cent. caoutchouc and 94·0 per cent. resin. It bears large fruits in profusion, which ripen all the year round, are eaten both ripe and unripe, and are considered a useful famine FOOD, being ground to a powder and mixed with flour. The leaves are used for cattle and elephant fodder. The WOOD is not durable, but is utilised for well-frames and for rough purposes, such as outhouse doors and cross pieces for carts. [*Cf. Pharmacog. Ind.*, 1893, iii., 338–42; Duncan, *Dyes and Dyeing, Assam*, 1896, 25; Innes, *Jungle Prod.*, 1897, 8, 11; Dutt, *Mat. Med. Hind.*, 1900, 321; *Agri. Ledg.*, 1902, No. 1, 53; 1904, No. 4, 28–30.]

F. infectoria, *Roxb.*; *Rec. Bot. Surv. Ind.*, i., 94; ii., 138, 188, 340, etc. The *pilkhan, ramanjír, pákri, kaim, pákar, baswesa, prab, safed kabra, kangji, pepere, serilli, war, batbar, jangli pipli, trimbal, bassari, jovi, tsjakela, nyaunggyin, kalaha, plaksha*, etc. A large (at first often epiphytic) tree found in the Sub-Himalayan tract from the Salt Range to Sikkim, and thence throughout India, Burma and Ceylon. It is more commonly planted than wild. There are in India three varieties.

Varieties.
Fibre.
Food.
Charcoal.

The bark is said to yield a fair FIBRE. The bark is one of the five known as *panchavalkala*, or the five barks. The young shoots are eaten by the Natives, and the leaves make good elephant and cattle fodder. The WOOD is sometimes used for charcoal, but not otherwise. [*Cf.* Dutt, *Mat. Med. Hind.*, 1900, 235; Innes, *Jungle Prod.*, 1897, 9.]

Pipal.

F. religiosa, *Linn.*; Cameron, *For. Trees Mysore and Coorg*, 1894, 283 4; *Rec. Bot. Surv. Ind.*, i., 70, 89, 185, 209, etc.; *Ind. Gard.*, March 1899, 87; Woodrow, *Gard. in Ind.*, 1899, 453. Known as the *pipal* or *peepul*, the *asvattha* of the classics, and by the following, among many other vernacular names:—*pipal, ashvatha, aswat, hesar, jari, bor-bur, ali, arasa, rái, ragi, basri, haspath, nyaung-baudi, bo*, etc. A large tree (usually starting as an epiphytic) without aerial roots. It is found in the Sub-Himalayan forests from the Panjáb eastwards; Bengal, Orissa and the Circars; Central India and Upper Burma. Is extensively cultivated and held sacred both by Hindus and Buddhists.

Sacred.

The bark yields a tenacious milky juice, which hardens into a substance resembling CAOUTCHOUC. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 25) mentions that a sample examined by him contained only 12·5 per cent. caoutchouc and 84·8 per cent. resin. The stem has also been stated to afford a resinous GUM, used as sealing-wax and employed by artificers to fill up the cavities of hollow ornaments. In the *Ahmedabad Gazetteer* (iv., 24) it is said to give a wax which is used in staining ivory red, but as this tree is one of the chief sources of LAC, this gum may simply be the excretion of the lac insect and not a gum at all. Among the Santals the milky sap is known as *lóré*. A birdlime is prepared from it, called *shelim* in the Deccan. From the bark a FIBRE is extracted, which was formerly made into paper in Burma and employed in the manufacture of the umbrellas of that province. The bark is a useful TAN and yields in boiling water a dye of a faint reddish-fawn colour. With other barks it is converted into a black DYE, while the root boiled in water with alum gives a pale pink on cotton cloth. The leaves, bark and fruit are all employed in Native MEDICINE. The small figs as also the bark are used as famine FOODS, and the twigs and leaves as elephant and cattle fodder. The WOOD is utilised for packing-cases and for fuel, occasionally also for charcoal. [*Cf. The Bower Manuscript* (Hoernle, transl.), 1893–7, 186; Duncan, *Dyes and Dyeing, Assam*, 1896, 25; Innes, *Jungle Prod.*, 1897–9; *Agri. Ledg.*, 1902, No. 1, 53; 1904, No. 4, 31; Joret, *Les. Pl. dans L'Antiq., etc.*, 1904, ii., 293–4.]

Milky Sap.
Lac.
Fibre.
Paper.
Tan.
Dye.
Medicine.
Fodder.
Timber.

FISH AND FISHERIES OF INDIA.—Day, *Fa. Br. Ind.* (*Fish*, 2 vols.); PISCES. The information available regarding the FISH and FISHERIES and the associated industries of India is very extensive and varied. The space available here may perhaps accordingly be best utilised by furnishing as complete an enumeration of the more valuable works, reports and magazine articles as possible. This may be referred to (1) a citation of general publications, then followed by (2) a series assorted provincially:—

D.E.P., iii., 363–97.

Marco Polo, *Travels*, 1290 (Fish in Aden) (ed Yule), ii., 377; Linschoten, *Voy. E. Ind.*, 1598 (ed Hakl. Soc.), ii., 11–7; Mandelslo, *Travels*, 1662, in Olearius, *Hist. Muscovy, etc.*, 87; Fryer, *New Acc. E. Ind. and Pers.*, 1675, 67, 116, 119; Tavernier, *Travels Ind.* (ed. Ball), 1676, i., 75; Terry, *Voy. E. Ind.* (ed. 1777), 7–11; Buchanan-Hamilton, *Fishes of the Ganges*, 1822, in Montgomery Martin, *Hist. E. Ind.* (a work that incorporates all the results of Buchanan-Hamilton's survey of the districts of Bengal, 1807–13), 1838, 3 vols.; Crawfurd, *Journ. to Ava*, 1834, ii., 176; Robinson, *Desc. Acc. Assam*, 1841, 119–23; Cantor, *Fishes of the Bay of Bengal*, in *Proc. Roy. As. Soc.*, 1838, 52; Royle, *Production Isinglass*, 1842; Vigne, *Travels*, 1848, ii., 409; Crawfurd, *Dict. Ind. Islands*, 137–8; Day, *Rept. Fresh Water Fisheries of Ind. Empire*; also *Sea Fisheries*, 1873; Day, *Fishes and Fisheries of Beng.*, in Hunter, *Stat. Acc. Beng.*, xx., 1–120; Thomas, *The Rod in Ind.*, 1897; Anderson, *Mandalay and Momein*, 1876, 24; Anderson, *Fisheries Exhib. Cat.*, 1884; Hunter, *Fish Curing*, in *Imp. Gaz.*, 1885, i., iii., v., xii., etc.; Bailey, *Bamboo Fishing Rods, Ind. For.*, 1887, xiii., 522; 1888, xiv., 418; 1889, xv., 92; 1897, xxiii., 148, 207–8; *Journ. Bomb. Nat. Hist. Soc.*, xii., 194–201, 404–9; xiii., 113–20, 355–61; also Trawling, xii., 580–5; Townsend, *Deep Sea Fishing*, xiv., 372–4; xvi., 318–33; Bassett-Smith, *Poisonous Fish*, xv., 719–20; Simmonds, *Waste Prod.*, 1876, 120; Allen, *Comm. Organic Anal.*, 1898, iv., 20–73; *Hobson-Jobson* (ed. Cooke), 1903, 126; Loach, *Food Inspect. and Anal.*, New York, 1905, 198–9.

BENGAL: Buchanan-Hamilton in Montgomery-Martin, *l.c. Bihar and Patna*, 227–9; *Bhagalpur*, 149–52; *Dinajpur*, 765–74; *Purnea*, 190–4; *Rangpur*, 584–94; *Gorakhpur*, 508–11; Sen, *Rept. Agri. Stat. Dacca*, 1889, 57–60; Banerjei, *Agri. Cuttack*, 203. UNITED PROVINCES: *Gaz. Bandelkhand*, 1874, i., 249–50; *Meerut*, 1875, ii., 52–8; *Etawa*, iv., 245–6; *Oudh*, 1878, iii., 99–100; *Gorakhpur*, 1881, vi., 318–20; *Basti*, 1881, vi., 579–82; *Shahjahanpur*, 1888, ix., 34–9; *Himalayan Dist.*, 1881, xi., 79–81. PANJÁB: *Gaz. Muzaffargarh*, 1883–4, 30–2; *Ludhiana*, 1884, 17. BALUCHISTAN: Hughes-Buller MS., *New Gaz.* BOMBAY AND SIND: *Gaz. Kaira*, 1879, iii., 20–4; *Ratnagiri*, 1880, x., 99–103; *Thana*, 1882, xiii., 54–9; *Kanara*, 1883, xv., 107–12, 300–14; *Kolaba*, 1883, xi., 37-9, 68-71; *Janjira*, xi., 474-82; *Kathiawar*, 1884, viii., 106-7, 154; *Ahmednagar*, 1884, xvii., 41-5; *Sholapur*, 1884, xx., 18-22, 151-6; *Dharwar*, 1884, 42-4; *Poona*, 1885, 87-93, 387-93. CENTRAL PROVINCES: Fuller, *Fishing Instruments*, 1883. MYSORE: Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, iii., 105-6, 342-5. MADRAS: Sturrock, *Man. S. Canara*, 1894, 46-8; Thurston, *Sea Fisheries of Malabar and S. Canara*, in *Madras Mus. Bull.*, 1900, No. 2. ANDAMAN ISLANDS: *Admin. Repts.* BURMA: Fenwick, *Journ. Agri.-Hort. Soc. Ind.*, 1849, vii., 67; Smeaton, *Fishing Implements* (reprinted by Mukharji in *Amsterdam Exhib. Cat.*, 1883); *Br. Burma Gaz.*, 1880, i., 641-97, 417-8; *Settl. Bassein*, 1883, 20-2; *Gaz. Mergui*, 1880, 19-28; *Henzada*, 1886, 7; *Amherst*, 1893, 31-7, 39; *Sagaing*, 1903, 29-32; *Toungoo*, 1901, 25; *Rept. Inland and Sea Fisheries in the Thongwa, Myaungmya and Bassein Dist. and Turtle-banks, Irrawaddy*, 1902; Max and Bertha Ferrars, *Burma*, 1900, 89-90; Nisbet, *Burma under Brit. Rule and Before*, 1901, i., 361-2.

The following are some of the chief commercial headings under which particulars regarding fish and fish products may be found in this work:—**Bêche-de-Mer** (p. 122); **Fish and Fisheries** (the present article); **Fish-maws and Shark-fins** (p. 542); **Isinglass and Glue** (pp. 542-3, 695); **Oils and Fats—Animal** (pp. 811-4).

Other kindred subjects are:—**Pearls and Pearl Fisheries** (p. 557); **Shells: Conch, Chank, Mother-of-Pearl,** etc. (pp. 558, 989).

It may be said that while the products afforded by fish are many and varied, the information available regarding them is fragmentary and unsatisfactory. The majority of fish are of course cooked and eaten either fresh or after being salted, sun-dried, smoked, pickled, preserved in oil, etc., etc. But unfortunately it is next to impossible to learn actual particulars of the fisheries and fish-curing industries that could be regarded as of a practical and commercial value. Much has been published, but either of a purely scientific character or of a most discursive nature.

Bengal.
Exports.

PRODUCTION.—Bengal.—In the trade returns of Bengal, for example, repeated mention is made of exports in dried fish and prawns. It is also known that a fair business is done in smoked, pickled or otherwise preserved mango-fish, *hilsa* (sable), and *begti* (cock-up), the last mentioned being often prepared in the form known as "tamarind-fish," but nothing for certain is known of the sources of supply or the centres of manufacture in Bengal or even in Calcutta. It is recorded that Calcutta obtains fish from Goalundo, from East Bengal, from Diamond Harbour, from Mutta and other localities in South Bengal. Moreover, though repeated efforts have been made (and indeed are being made) to organise a systematic supply of sea-fish, the Calcutta market is almost exclusively met by fresh-water fish. The supply of excellent *begti*, procured both direct from the rivers or from special rearing-tanks, is very great and the quality excellent. During their respective seasons both mango-fish and *hilsa* are plentiful, the latter caught very largely in the Ganges and conveyed by special fish trains to Calcutta. Tank-reared fish may be spoken of as an important feature of the Bengal supply. The sale of live fry for the purpose of annually stocking tanks is accordingly a fairly important special industry. The fry are caught on the surface of the shallow water near sandbanks in the rivers, and are carried inland in earthen pots to be sold to the owners of rearing-tanks.

Calcutta.
Supply.

Tank Fish.

Upper India.

Poor Supply.

Upper India may be spoken of as entirely dependent on its rivers for its supply of fish. At one time a great effort was made to convey sea-fish from Karachi as far inland as Simla, but the venture was evidently not profitable as it was discontinued. The military stations of the Panjáb, however, do in some cases get fresh sea-fish from Karachi. Near the larger rivers the towns such as Lahore, Delhi, Agra,

Assam.

Allahabad, etc., obtain a fair supply at certain seasons, but fish is by no means the important article of diet in Upper India that it is in the western, southern and eastern provinces. In Assam excellent river-fish may be had, one of the most highly prized being the *bassa*, which when smoked is an excellent addition to the breakfast table, and by some the King-fish —***Semiplotus macclellandi*** (Day, *l.c.* i., 281)—or *sundari* is even more highly prized.

Bombay and Karachi.

Exports.

Oysters.

Bombay and Sind.—The trade returns of Bombay frequently make mention of *bummelo* ("Bombay duck"), "tamarind-fish" of various qualities, such as *seir* (white-pomfret)—the best quality. Bombay has an excellent supply of sea-fish, and accordingly fresh-water fish are nearly as rare in the western capital as sea-fish are in the eastern. Calcutta visitors to Bombay accordingly much appreciate the pomfret and sole they receive there, just as the Bombay visitors extol the Calcutta *begti* and mango-fish. Bombay oysters have, as a rule, an evil reputation among Europeans, but all the same there exist extensive beds for their production and a by no means unimportant traffic in that shell-fish. The exports to China of Shark-fins and Fish-maws (see p. 549) are by far the most important single item in the Bombay foreign trade in fish. Karachi holds, however, an even more important position in the fish trade of Western India than Bombay. The oysters of Karachi are regarded as the best in all India. The pomfret, sole and other fish procured in Karachi are excellent, and of a flavour only to be compared with those in the extreme south, such as at Cochin and Calicut. A large trade is at the same time done in shark-fins and fish-maws from Karachi, as also in Isinglass and Fish-oil (p. 545). The Persian Gulf traffic in salted and sun-dried fish is very ancient. Marco Polo (*Travels*, 1290 (ed Yule), i., 102, also n. 109) alludes to the people of Hormuz living on dates and salt fish. Date and dry-fish diet is alluded to also by Ibn Batuta.

South India.

Fish Curing.

Oil.

Liberal Supply.

Madras.—This is perhaps the most important province in the fish trade of India. From ancient historic times the sun-dried, salted and pickled fish of the southern Malabar Coast have not only permeated over a large part of India but been carried to foreign countries. Difficulties in the Indian fiscal regulations with salt have for some years been loudly proclaimed as having restricted if not curtailed that industry, and the subject has received (and is receiving) the most careful consideration not only of the local but of the Imperial Government. The tamarind-fish of Cochin is chiefly made from the *seir*, and the fish-oil—so much extolled over India —is made mainly from the sardine (see **Oils**, pp. 544–5). Under **Bêche-de-Mer** (pp. 122–3) reference has been made to the Madras traffic in sea-slugs. Oysters are specially cultivated at several centres, and the supply is both large and excellent. South India has thus a liberal stock of most admirable sea-fish (pomfret, sole, sardine, etc.) of all kinds, and in the vicinity of its large rivers a supplementary supply of fresh-water fish. Important fisheries exist, as well as valuable industries in Pearls, Conch, Chank and Mother-of-Pearl (see p. 557).

Burma.

Sea-slugs.

Burma.—Speaking of Further India, the trade returns show a considerable traffic in locally produced sea-slugs, as also in foreign slugs imported and to a certain extent again re-exported. There are also valuable local fisheries and fish-curing centres in Burma. The salting and preserving of fish have in fact assumed special forms more or less characteristic. The *Gazetteer of Upper Burma and the Shan States* (ii., pt. i., 433) gives, for example, a useful sketch of the fisheries and trade in fish on the Irrawaddy.

CHIEF INDIAN FISH AND FISHERIES.—The following are some of the more important aspects of the fish supply of India, of fish products, and of the special preparation of fish, met with in Indian commerce :—

1. "***BOMBAY DUCK***" ***OR BUMMELO FISH.***—This is the fish—***Harpodon neherens*** (Day, *l.c.* i., 412), known in the vernacular as *nehare, bumalo, cucah saurahri, coco mottah, bili,* etc. It is common in the seas and estuaries of India, more especially Bombay. It is highly esteemed as food when eaten immediately after being caught. Since it rapidly goes bad, it is at once salted and subsequently sun-dried, and in that condition alone is known to most people. It is the relish served with curries that bears the name "Bombay Duck"—a quaint and obscure name that has an analogy in "Digby chicks." Boswell (*Tour to the Hebrides*, 1773) compares the Bombay ducks to the sun-dried whitings of Aberdeenshire, known as "Speldings."

River-fish.

Mahasir.

Hilsa.

Ruhu or *Ru*

2. ***FRESH-WATER FISH.***—It would occupy much space to mention all the fish of this class that might be regarded as worthy of interest. A special feature of Indian rural life, and one that is capable of considerable improvement, is the rearing of fish in tanks, an industry already briefly alluded to. Tanks are necessities of life in large tracts of country in order to supply water, and that they are utilised as sources of edible fish is not only natural and economical but essential to the purity of the water. A large number of the Indian fresh-water fish naturally frequent backwaters of] the rivers; in other words are not averse to live in tanks. This has led to the traffic already mentioned of catching and selling live fry with which to stock tanks that are even remote from the rivers. The following are some of the better known river-fish, many of which can be reared in tanks: -***Anabas scandens*** (Day, *l.c.* ii., 367), the Climbing Fish or *coi, sennal, nga-pri, harúan,* etc.; these are often carried alive by the boatmen of the Ganges, being killed and cooked as required. They may be kept alive for a long time in damp earthen pots and thus conveyed to a distance. ***Barbus***, the Carp: various species, especially ***B. sarana*** (Day, *l.c.* i., 300), the *sarana* or *durhie*, and ***B. tor*** (*l.c.* i., 307), the *mahasir*; most highly prized of sport-giving fish and found in hill streams. ***Barilius bola*** (*l.c.* i., 352), the trout of Indian streams. ***Catla buchanani*** (*l.c.* i., 287), largely employed for stocking tanks in Bengal, United Provinces and Panjáb. ***Clupea ilisha*** (*l.c.* i., 376), the *sable* or *hilsa*, a sea-fish that passes up most of the rivers of India and Burma, and is one of the most important of the fresh-water fishes. ***Eutropiichthys vacha*** (*l.c.* i., 128), the *bassa* of Assam, is found in most of the larger rivers of India. ***Labeo*** (*l.c.* i., 256), the Kalban fish: several species are common in the rivers and much used for stocking tanks, such as ***L. calbasu*** (*l.c.* i., 259), Panjáb, Sind, Kach, Deccan, etc., ***L. gonius*** (*l.c.* i., 261), the *cursa*, much used in the United Provinces, Bengal, Orissa, Ganjam and Kistna. ***L. rohita*** (*l.c.* i., 262), the *ruhu* or *rui*, an excellent fish, and accordingly carefully propagated in the tanks of Bengal. ***Ophiocephalus*** (*l.c.* ii., 360): several species of the so-called Walking Fish or Murral, such as ***O. barca*** (*l.c.* ii., 361); may be carried in damp vessels for great distances, sold alive, and cooked as required. ***O. marulius*** (*l.c.* ii., 360) and ***O. striatus*** (*l.c.* ii., 363) are excellent for stocking tanks. ***Pseudeutropius taakree*** (*l.c.* i., 138), Poona and Deccan. ***Rita buchanani*** (*l.c.* i., 165), found in the Jumna, Ganges and Irrawaddy, is valuable for its capability of retaining life long subsequent to the removal from water.

Shark-fins.

Oil.

Shagreen.

3. ***FISH-MAWS AND SHARK-FINS: ISINGLASS.***—The trade in these articles is a fairly ancient one. Milburn (*Or. Comm.*, 1813, i., 109, 283) makes reference to them. "Fish-maws," he says, "are an article of trade from various parts of China, where they are much esteemed." So again, "Shark-fins are an article of trade from the Arabian and Persian Gulfs and from thence to China; they are esteemed very strengthening by the Chinese." "They are likewise prepared on the Malabar and Coromandel Coasts and many of the islands in the Indian Ocean." The commercial products given as the title of this paragraph are not, however, the only products afforded by the group of fish placed in this position. The flesh (especially of the young) is often valued as an article of food; the fins are employed in making jellies and soups, mainly by the Chinese; the livers afford an oil, which when carefully prepared (more especially of certain species) is spoken of as a useful substitute for cod-liver oil; and the skin of most species is made into the substance known as SHAGREEN. The group of fish here indicated might be

defined as the Sharks, Ray-fish, Skates and Saw-fish. On the other hand, fish-maw, which in a purified form is known under the name of isinglass (or, to be more accurate, fish isinglass) is a substance usually obtained from a widely divergent assemblage of fish. It is simply the "sound" or "air-bladder" and might be prepared from almost any fish, though certain species are more highly valued than others. It may accordingly be desirable to refer these to two sections:—

(*a*) ***Shark-fins.***—Day (*l.c.* i., 3) wrote, "These fish are employed as food, and portions of them, especially the fins, are largely exported from the Indian to the Chinese markets. In China Dr. Cantor observed that the fins were not exclusively selected from the sharks—***Selachoidei***—but equally from the rays—***Batoidei.*** Among those examined at Penang were found to be fins taken from the fishes belonging to the following genera:—***Carcharias, Zygæna, Stegostoma, Pristis, Rhinobatus, Trygon*** and ***Myliobatis.*** Gelatine is obtained from the larger fins, glue from the smaller. All except the caudal fins are cut from the fish at the root, so as to leave as little flesh as possible. The root is dipped into wetted lime (*chunam*) and then the fins are dried in the sun, and according to their value they are divided into two kinds: "white" and "black." The white consists exclusively of the dorsal fins, which are on both sides of a uniform light colour, and are expected to yield more gelatine than the other fins. The pectoral, ventral and anal fins pass under the denomination of "black fins"; the colour, however, varies from buff to grey or brown, and most of them are of two different colours, the upper surface being dark and the lower light. The black fins of course are the most numerous, and supposed to yield a comparatively small quantity of gelatine." In another passage Day (*l.c.* i., 5) remarks:—"The fins of the sharks are removed and dried in the sun. Strips of the flesh are also salted as food and the livers boiled down for the oil they contain." "Some forms of large sharks, as ***Galeocerdo,*** which have the edges of their broad teeth sharp or coarsely serrated, cannot be captured by nets, as they at once cut their way out. But nets are suitable for such species as possess conical teeth; these last may likewise be taken by baited hooks attached to cords composed of many strands, through which the teeth penetrate but do not cut." A curious circumstance regarding the special nets used on the coast of Karachi may be here mentioned, namely that they are made very largely of the fibre derived from ***Calotropis procera*** (see p. 206), a fibre hardly utilised in any other part of India, but the place of which is taken in Eastern India by rhea fibre (see p. 157), both fibres being selected on account of their great strength and durability under water.

Gelatine Glue.

White and Black Fins.

Salted Flesh.

Nets.

The following are the chief Indian fish that afford "Shark-fins":—***Aetobatis narinari*** (Day, *l.c.* i., 59), the Devil Fish; ***Bagarius yarrellii*** (*l.c.* i., 194), the fresh-water shark, the *búnch* or *gúnch*; ***Carcharias acutidens*** (*l.c.* i., 11), a shark of the coast of Sind and the Indian Ocean; ***C. gangeticus*** (*l.c.* i., 13), one of the most ferocious of Indian sharks; ***C. limbatus*** (*l.c.* i., 17); ***C. melanopterus*** (*l.c.* i., 14), *caval sorrah* or *raman sorrah*; and ***C. menisorrah*** (*l.c.* i., 16); ***Pristis cuspidatus*** (*l.c.* i., 37), the Saw-fish; ***Pteroplatea micrura*** (*l.c.* i., 56); ***Rhynchobatus ancylostomus*** (*l.c.* i., 41), the Mud-skate; ***R. djeddensis*** (*l.c.* i., 40), the *ulavi* or *ranja*; ***Trygon sephen*** (*l.c.* i., 50), the Ray; ***T. narnak*** (*l.c.* i., 53), the *sankush, hankus;* and ***Zygæna malleus*** (*l.c.* i., 22), the Hammer-headed Shark.

(*b*) ***Fish-maws and Isinglass*** (see **Isinglass**, p. 695).—Vulgarly the term Isinglass is sometimes given to Mica. The English word is a corruption of the Dutch *huisenblas* (=sturgeon-bladder). It may be obtained from many substances, and according to the Greeks it was *icethyocolla* or fish-glue. As already explained, the finer qualities are the "sounds" or "air-bladders" of fish. The true isinglass of European commerce is the sound of the sturgeon (***Acipenser***), Brazilian isinglass is derived from one or two species of ***Silurus***, and the Indian isinglass from one or other of the following fishes:—***Arius acutirostris, burmanicus, cælatus, falcarius, gagora, sona,*** and ***sagor*** (Day, *l.c.* i., 173–88). These are largely prepared and salted on the Western Coast (Karachi), but at the mouths of the Ganges there is also a fair and improving trade:—***Osteogeniosus militaris*** (*l.c.* i., 190); ***Otolithus maculatus*** (*l.c.* ii., 127), the *birralli* of Orissa; ***O. ruber*** (*l.c.* ii., 128), the *jarang-gigi* (or *péchepierre*) of Pondicherry; ***Pristipoma guoraca*** (*l.c.* i., 512), the *gouraka*; ***Serranus diacanthus*** (*l.c.* i., 449), the *damba;* ***Silundia gangetica*** (*l.c.* i., 145); and the ***Umbrina russellii*** (*l.c.* ii., 110). [*Cf.* Royle, *Prod. Isinglass;* Day, *l.c.* (*Fishes*) i., 3, 5, 7–63; Hunter, *Imp. Gaz.*, iii., 434.]

Isinglass.

4. ***FISH MANURE.***—When procured in excess of demand for human food, large

Manure.

quantities of fish are utilised as manure near the coast towns of India, very much as in some parts of Europe. Thurston (*Bull. Mad. Mus.*, 1900, No. 2., 120–3) gives much information on the extent to which the sardine is employed as manure, the supply ranging from 2 to 515 tons a year. Fish manure is not unknown to the coffee planters, and Mollison says that for sugar-cane culture this manure is much valued. The Malayas consider the fish ***Echeneis naucrates*** (*l.c.* ii., 214) as specially suitable as a manure for fruit trees. [*Cf.* Simmonds, *Waste Prod., etc,* 155–77; Lehmann, *Rept. Agri. Cult. Chem. Mysore,* 1901–2, 14; Mollison, *Textbook Ind. Agri.*, i., 107–8.]

Medicine.
Indian Cod-liver

5. ***MEDICINE.***—The bile of certain species of fish is believed to be a valuable medicine, especially that of the *ruhu* or *rui* (***Labeo rohita***). [*Cf. Taleef Shereef,* (Playfair, transl.), 1833, 150.] The brine of pickled fish is alluded to by Paulus Æginota (Adams, transl., iii., 81). Fish diet is by the Hindus considered safer for invalids than the flesh of other animals. The oil prepared from many species is used as an efficient substitute for cod-liver oil.

Ngapee.

6. ***NGAPEE*** (*Ngapi*).—In an official report issued in 1902 (though not offered for sale) by the Government of Burma on the Inland and Sea Fisheries, reference is made to the account of this preparation as given in the *Dictionary.* The passage in question was reprinted direct from the description of Tenasserim, written by H. Fenwick in 1849—presumably an authority on Burmese matters of the date in question. The recent official publication enumerates and describes some eighteen different forms of *ngapi,* the particulars given occupying five pages of closely printed foolscap. It concludes by asking the question, "Why does *ngapi* smell, it will be asked? Because, however carefully the stuff is made, there must be always a considerable proportion of uncured flesh, flesh that the salt cannot reach. This flesh decays and rots, but the rest is properly cured fish." To many persons preserved fish in any form is objectionable. The danger of eating a proportion of rotten uncured flesh, however small, may be suggestive of poison and doubtless dictated the appellative "semi-putrid fish" used by Fenwick. The following passage from Nisbet (*l.c.* i., 361) fairly represents all that is known regarding the preparation of *ngapi.* "Immediately after being caught and brought to land the fish are either scaled by hand or have the scales roughly brushed off with a frayed bamboo, and are then thrown into a wooden trough, the larger being gutted and deprived of head and fins. After being rubbed with salt they are packed in baskets and pressed down by means of a board weighted with large stones. Next morning they are unpacked and again rubbed with salt, then spread out on thin bamboo mats to dry in the sun until the afternoon of the following day, when they are packed alternately with layers of coarse salt in large earthenware jars placed in the shade. To retard the process of liquefaction of the salt, the powdered bark of the *ondon* tree (***Litsæa sebifera***) is mixed with it; but, during the three to five weeks this rough method of pickling is allowed to continue, the oily brine oozing to the top and evaporating, sometimes becomes so full of maggots before drying up that fresh supplies of salt have to be added. The scaleless siluroid mud-fishes are those most easily treated in this way."

Smell of.

Preparation.

Ngathalauk.

"Greater care is taken in the preparation of *ngathalauk* (***Clupea palasah***), the *hilsa* of Indian rivers, which are simply gutted but not otherwise cleaned, and then salted and sun-dried before being spread between thin bamboo mats and pressed for about three days. These dried fish (*ngachauk*), the daintiest of Burmese condiments, are both in preparation and in transport handled separately, whereas the stinkingly offensive *ngapi* is sold in bulk, in baskets and sacks. Both varieties are cooked by roasting or frying when used to flavour the meal of boiled rice."

Fish-paste.

"Along the Tavoy and Mergui coast a finer quality of fish-paste is made with shrimps and prawns, which are worked up with salt when half-dried in the sun. As this is eaten uncooked, it is termed *seinsa* or 'raw food.' The more carefully prepared paste, made with selected small prawns, is frequently used with curry and rice as a chutney by Europeans all along the Malay coast, where it is known as *balachong;* and of recent years it has competed with caviare as a *bonne bouche* in the boulevard restaurants of Paris." [*Cf.* Mandelslo, *Travels,* 1639, in Olearius, *Hist. Muscovy, etc.*, 121; Symes, *Emb. to Ava.*, 1795, ii., 371; Crawfurd, *Journ. to Ava,* 1834, ii., 176; *Gaz. Upper Burma and Shan States,* ii., pt. i. 433.]

Balachong.

D.E.P.,
ii., 155;
iii., 368,
375-6,
379, 462.
Fish-oils.

7. ***FISH-OIL*** may be referred to two sections :—

(*a*) ***Shark, Ray and Skate Oils.***—These are sometimes treated separately or mixed (as procured). In the former case an oil is often prepared from some of the

Liver Oils.

species that might be used as a substitute for cod-liver oil. Thus, for example, Day (*l.c.* i., 5) says: "At Calicut, medicinal fish-liver oil of an excellent quality was formerly manufactured, a small factory for this purpose having been constructed at that station in 1854, and the livers of sharks and saw-fishes were purchased from the fishermen. The abundance or paucity of these fishes evidently depended to a very great extent upon whether sardines were or were not present, for these latter forms of ***Clupeidæ*** are very capricious, sometimes forsaking the coast for several successive years, and then as suddenly reappearing in countless millions. No livers under 40 lb. weight were accepted at the factory, as the larger ones gave proportionally a greater amount of oil than the smaller ones; sometimes livers of a great size were purchased. One weighed 290 lb., and another from a female saw-fish, 14 feet long, 185 lb." The fish included in this paragraph have been enumerated under **Fish-maws and Shark-fins** above.

Illuminant Oils.

(*b*) ***Other Fish-oils.***—The livers, or the whole fish, of certain species that do not belong to the above group are known to afford excellent oils. These are mainly used for illuminating purposes, but some are of superior quality and may be even employed as articles of food. Such oils appear to be made of salt-water fish, all along the coast of India, and from fresh-water species, along the channels of the chief rivers. The following are the fish most highly spoken of as affording oil:—***Barbus chola*** (*l.c.* i., 317), the Bitter Carp of the rivers of India; ***Clupea fimbriata*** (*l.c.* i., 373), the Sardine; ***C. ilisha*** (*l.c.* i., 376), the Sable or *Hilsa*; ***C. longiceps*** (*l.c.* i., 373), the Malabar Oil Sardine; ***Cybium commersonii*** (*l.c.* ii., 211), the Seer or *konam*; ***Labeo rohita*** (*l.c.* i., 262), the *ruhu* of Indian rivers; ***Silundia gangetica*** (*l.c.* i., 145), found in the estuaries of India and Burma, the oil of which is much valued as a medicine.

Oil Trade.

Trade in Oil.—Thurston gives the fullest and most recent account of the Fish-oil trade of India. The following passage may, therefore, be abstracted from his most interesting and useful report:—" Hundreds of tons of fish-oil are said to have been annually exported from Cochin in former years, and I find that the average export thereof in the five years 1856 to 1861 was 19,630 cwt. The oil trade is, however, reported to be decreasing year by year. In some seasons the sardines arrive off the coast in enormous numbers, or, for several years consecutively, they may be present only in quantities sufficient for purposes of food. The result of this irregularity is that one very important element of success in commercial undertakings—regular supply—is wanting. In some years large shoals of sardines appear, and suddenly disappear. Contracts for the supply of oil are made on the arrival of the fishes, and, in the event of their disappearance, the contractor loses heavily. The Natives of Cochin say that formerly the sardines always arrived regularly, and remained throughout the season. And the fishermen's belief is that they are at the present day frightened away by the numerous steamers which call at Cochin, and retire in search of a less disturbed spot. In addition to steam-boat traffic, noises in boats, ringing church bells, artillery practice, the erection of lighthouses, gutting fish at sea, using fish as manure, burning kelp, and the wickedness of the people, have been charged with being responsible for a falling off of the fish supply. But, as Mr. Fryer naïvely remarks, of these alleged causes, only the last, it is to be feared, has been, and is likely to be, a permanent factor in the case."

Decreasing.

Sardine Oil.

Losses on Contracts.

Causes.

Manufacture.

" The preparation of the evil-smelling fish-oil is carried out in large iron cauldrons, in which the fish are boiled with a little water. The oil, as it exudes, rises to the surface, is strained through cloth, and stored in barrels. The residue in the cauldrons is preserved, and utilized as manure for cocoanut gardens, paddy (rice) fields, etc. A rougher and cheaper process of oil-extraction, by which the cost of cauldrons and firewood was saved, has practically been put a stop to as being an offensive trade. This process consisted simply in putting the fishes into a canoe, and exposing them to the influence of the sun until decomposition set in. The oil then rose to the surface, and was removed with a scoop. By this crude process a comparatively small quantity of the oil was extracted. A portion of the manufactured oil is consumed locally by boat-owners for smearing their boats, so as to preserve the wood and coir ropes (made from the fibre of the cocoanut husk) with which the timbers are stitched together. But the bulk is exported to Europe and some Indian ports. The Natives believe that the oil returns from Europe, masquerading in the guise of cod-liver oil." [*Cf. Eastern Indic.*, i., 229; Buchanan-Hamilton, MS. pub. by Day in Hunter, *Stat. Acc. Beng.*, xx., 85; *Japanese Sardine Oil*, in *Journ. Soc. Chem. Indust.*, 1887, vi., 372; Thurston, *Bull. Mad. Mus.*, 1900, No. 2.]

Crude Process.

Fish Poisons.

8. *POISONS OR INTOXICANTS USED TO KILL FISH.*—The following are the plants often used in India to kill fish:—***Albizzia stipulata***, and ***procera***; ***Anamirta Cocculus***, *W. & A.* (the seeds boiled in rice and made into a paste); ***Balanites Roxburghii***, *Planch*; ***Barringtonia racemosa***, *Bl.* (seeds mixed with bait); ***Bassia butyracea***, *Roxb.* (bark used in Sikkim); ***Berberis aristata***, *DC.* (bark); ***Crotalaria paniculata***, *Willd.* (according to Hooper, plant used); ***Derris elliptica***, *Benth.* (bark and flowers); ***Diospyros montana***, *Roxb.* (fruits); ***Euphorbia Tirucalli***, *Linn.*; ***Fluggea Leucopyrus***, *Willd.*, and ***F. microcarpa***, *Bl.* (the barks); ***Gynocardia odorata***, *Br.* (the fruit); ***Hydnocarpus venenata***, *Gaertn.* (fruit used): ***Lasiosiphon eriocephalus***, *Dcne.* (bark); ***Millettia Piscidia***, *Wight* (powder of bark and flowers); ***Mundulea suberosa***, *Benth.* (seeds and inner layer of bark); ***Randia dumetorum***, *Lamk.* (bruised fruits); ***Sapium indicum***, *Willd.* (the seeds used); ***Spilanthes Acmella***, *Linn.* (fruits); ***Strychnos Nux-vomica***, *Linn.*; ***Walsura Piscidia***, *Roxb* (bark thrown into tanks).

It has been pointed out that many of these contain saponin. All are more or less acrid and bitter. It is generally held that the fish taken by this process are quite wholesome. The practice is most reprehensible, since young and old are killed and more therefore destroyed than can be used. [Hooper, *Drugg. Bull.*, Nov. 1890.]

9. *ROE.*—The roes of certain fish are highly prized. They are often specially prepared and sold by themselves, just as in Europe the cod-roe is a recognised marketable article. The fish most generally resorted to for this purpose are the Gard fish of Malabar (***Hemirhamphus buffonis***) (*l.c.* i., 427), a fish found plentifully in the seas and tidal rivers of Bombay, Bengal and the Andaman Islands. So again the Corsula Mullet (***Mugil corsula***) (*l.c.* ii., 349) or the *undala*, *corsula*, *in-ge-li*, *nga-sheng*, etc., which Ainslie says affords a kind of caviar (caviare), as also the Common Mullet (***Mugil œur***) (*l.c.* ii., 348), the *kola-kende* or *muhlah*, yields roes that are much appreciated and are sold sun-dried.

Caviare.

Dried Fish.

10. *SALTED AND DRIED FISH.*—In official statistics this subject is dealt with under the following headings:—"Dry Unsalted Fish," "Dry Salted Fish," and "Wet Salted Fish." One of the most startling circumstances of the trade in fish is the fact that India is apparently not able to meet her own demands. Perhaps no other part of the globe (of a like magnitude) possesses so varied and extensive a series of marine and fresh-water edible fish, nor so many forms that lend themselves readily to artificial production in tanks and ponds. In spite of every advantage, however, the foreign imports far exceed the exports, thus showing that from one circumstance and another, India is not self-supporting in the matter of fish. Whether this proceeds from unskilled methods and imperfect appliances, or from the want of proper regulations and protective measures, in the form of a Fisheries Act, or from the restrictions that prevail in the supply of cheap salt for fish-curing, or from the climatic and social conditions of the country and people that are naturally opposed to the development of a fish-curing industry, are points of a highly controversial nature. The late Dr. Francis Day was of opinion that the Bengal supply had steadily declined, since the first decade of the nineteenth century, when Buchanan-Hamilton conducted his survey of that province and wrote his *Fishes of the Ganges*, owing, Day thought, to the selfish and destructive systems that were allowed to prevail. Be that as it may, it is certain that the past twenty or thirty years has witnessed the steady growth of an import trade in fish which has assumed no mean proportions.

India imports Fish.

Explanati

The following, arranged in alphabetical sequence of their scientific names, are the more important fish sold in salted condition:—***Aëtobatis narinari*** (*l.c.* i., 59), the Devil Fish; ***Arius cœlatus*** (*l.c.* i., 174), ***A. sagor*** and ***A. sona*** (*l.c.* 178–9); ***Chatoessus chacunda*** (*l.c.* 386), the Indian Herring; ***Chrysophrys berda*** (*l.c.* ii. 44), the Grey Perch; ***Clarius magur*** (*l.c.* i., 115); ***Cybium guttatum*** (*l.c.* ii., 210), Seer or *seir*; ***Cynoglossus*** *sp.* (*l.c.* ii., 452), the Soles known in South India as *mánthal*; ***Equula daura*** (*l.c.* ii., 188), the *dacer karah*, Coromandel; ***Gerres filamentosus*** (*l.c.* i., 537), the Udan; ***Harpodon nehereus*** (*l.c.* i., 412), the Bummelo, already discussed; ***Lutjanus argentimaculatus*** (*l.c.* i., 472), the Red Rock-cod; ***L. johngarah*** (*l.c.* i., 474), the *purruwa*; ***Mugil corsula*** (*l.c.* ii., 349), the Mullet; ***Pristis cuspidatus*** (*l.c.* i. 37), the Saw-fish; ***Rhynchobatus djeddensis*** (*l.c.* i., 40), the *ulavi*; ***Saccobranchus fossilis*** (*l.c.* i., 125), the Scorpion Fish; ***Sciæna bleekeri*** (*l.c.* ii., 112), the *soh-li*; ***Scomber microlepidotus*** (*l.c.* ii., 203), the Mackerel or *ila*; ***Stromateus cinereus*** (*l.c.* ii., 198), the Silver Pomfret; ***S. niger*** (*l.c.* ii., 199), the Black Pomfret; ***S. sinensis*** (*l.c.* ii., 197), the White Pomfret; ***Trachynotus ovatus*** (*l.c.* ii., 179), the *kútili* or *múkalí-parah*; ***Trichiurus haumela*** (*l.c.* ii., 134), the Puttiah; ***Trichogaster fasciatus*** (*l.c.* ii., 372), the *kolisha*, *nga-phyin-thaleb*—one of the fish made into *ngapi*; ***Trygon uarnak*** (*l.c.* i., 53), the Ray-fish, *sankush*.

Thurston (*l.c.* 1900, No. 2, 116 *et seq.*) should be consulted for particulars of the Indian methods of fish-curing. The bulk of the traffic, he says, takes place between September and March.

11. ***FISH SCALES.***—The scales of the *mahasír* (***Barbus tor***) are said to be employed in the manufacture of playing-cards. They are cut into circular pieces about 1½ inch in diameter, painted and varnished. The centre of the trade in this curious commodity appears to be Shahabad. In the Deccan the large scales of a carp are used in place of glass for windows. The scales of the Bleak and the Dace are in Europe employed in the production of a substance known as Essence d'Orient which is utilised in the manufacture of artificial pearls. [*Ind. Art at Delhi,* 1903, 202–5.]

Playing-cards.

Artificial Pearls.

12. ***SEA FISH.***—So many of the fish that should fall into this position will be enumerated under other headings that it is hardly necessary in this place to do more than mention a few of the more important species:—***Atherina forskalii*** (*l.c.* ii., 338), also ***Engraulis indicus*** (*l.c.* i., 394), both called Whitebait by Europeans in India; ***Chanos salmoneus*** (*l.c.* i., 403), the Milk Fish or White Mullet; ***Chatoessus chacunda*** (*l.c.* i., 386), the Indian Herring; ***Clupea fimbriata, lile*** and ***longiceps*** (*l.c.* i., 373–4), Sardines; ***Cybium guttatum*** (*l.c.* ii., 210) and ***C. commersonii*** (*l.c.* ii., 211), *seir*; ***Cynoglossus lingua*** (*l.c.* ii., 454), the Sole of Europeans in India, or *kot-aralu*, a fish highly esteemed in the coast towns of India; ***Dussumieria acuta*** (*l.c.* i., 399), the Malabar Sardine; ***Harpodon nehereus*** (*l.c.* i., 412), Bombay Duck; ***Lates calcarifer*** (*l.c.* i., 440), the Cock-up or *nair*, the *begti*; ***Mugil corsula*** (*l.c.* ii., 349) and other species, the Mullet; ***Polynemus indicus*** (*l.c.* ii., 105), the Rowball of Vizagapatam, the *selé*, is one of the chief sources of the "Fish-maws"; ***Scomber microlepidotus*** (*l.c.* ii., 203), the Mackerel; ***Sillago sihama*** (*l.c.* ii., 224), the Whiting of Europeans in Madras; ***Stromateus cinereus*** (*l.c.* ii., 198), the Silver and Grey Pomfret; ***S. niger*** (*l.c.* 199), the Black Pomfret; ***S. sinensis*** (*l.c.* 197), the White Pomfret; and ***Upeneoides vittatus***, the Mullet (*l.c.* ii., 25).

13. ***SHAGREEN OR FISH-SKINS.***—The rough skins of many species of fish are used as a kind of sand-paper, and that of certain sharks, rays and skates is made into the substance known as shagreen. This is a thick skin covered with hard enamelled papillose scales. After being cured and stained it is employed to cover boxes, scabbards, sword-handles and other such purposes. In some respects the shagreen from the ray-fish and certain species of dog-fish is regarded as superior to that of the shark. In Hunter (*Imp. Gaz.*, x., 252) mention is made of shagreen manufactures at Nawanagar; also in Milburn (*Or. Comm.*, ii., 511), Horse-skins. The following afford shagreen:—***Pristis cuspidatus*** (*l.c.* i., 37), the Sawfish; ***Rhynchobatus ancylostomus*** (*l.c.* i., 41), the Mud-skate; ***Trygon sephen*** (*l.c.* i., 50), the Ray; ***Zygæna malleus*** (*l.c.* i., 22), the Hammer-headed Shark. Hoey (*Monog. Trade and Manuf. N. Ind.*, 1880, 94) describes the process of making horse or asses' hides into an imitation shagreen known as *kimukht* and *kirkin*.

Shagreen.

Imitation.

14. ***SMOKED FISH.***—While the art of curing fish by smoking them seems to have been known to the Natives of India from fairly ancient times, it cannot be said that it has assumed a position of such importance as in Europe. The *hilsa* or Sable, ***Clupea ilisha*** (*l.c.* i., 376), is the fish most noted as being in India cured by being smoked. The Mango-fish, ***Polynemus indicus*** (*l.c.* ii., 105), is a fish that must be eaten immediately after being caught. Accordingly, to allow of its being carried to a distance it is sometimes smoked. The *bassa* of the rivers of Assam, Bengal, Orissa, etc., is also a fish often smoked, but these and other instances are more a consequence of special demand by the Europeans than a regular Native industry. The smoke from burning refuse sugar-cane is that most generally used.

Smoked Fish.

15. ***SOAP.***—Several methods of utilising fish and fish-offal in the production of soap have been discussed by several writers, but no actual industry exists in India for this purpose. [*Cf.* Simmonds, *Waste Prod.*, 148.]

16. ***TAMARIND-FISH.***—Fish pickled in a preparation of tamarinds is known in Indian trade by this name (see p. 1067). The species most frequently treated in this way are ***Cybium guttatum*** (*l.c.* ii., 210), the *seer* or *seir* fish, and ***Lates calcarifer*** (*l.c.* i., 440), the Cock-up or Nair fish, the *begti* of Bengal. Thurston says: "In

Tamarind-Fish.

the ordinary method of preparation, the fish is boiled, and, after removal of the bones, cut in thick slices, highly spiced and left to soak, packed in a jar. But the following account of a new and improved process has been sent to me by Mr. Sherman. "Fish of all sizes can be cured, but, for Colombo market, mackerel are preferred. The fish are not slit open, but neatly gutted by extracting the entrails through the gill-opening. They are then carefully washed and packed, with alternate layers of salt, in big casks, which are procured locally and sold in Colombo with the fish. To each maund of the fish about 7 lbs. of tamarind fruit (*goorakapully*) are used." "The casks are stored on end and filled to the full. The fish is allowed to soak and pickle for four days, and the brine is then drawn off until it is about a foot from the bottom, and thus leaving enough brine to keep the whole cask moist when closed. Under this new system 1,658 mds. 5 seers of mackerel, with 375·7 mds. of salt are used, or 18·6 lbs. per maund against 12·5 lbs. used in the usual west coast method of curing."

Trade in Fish.

Legislatio

Fish-curing Yards.

Provision of Salt.

TRADE IN FISH.—It has often been urged that India is most neglectful of her food resources in this direction. With a little care the rivers and tanks might become very much more important sources of supply, and indiscriminate and wasteful methods of fishing, both in fresh and sea water, account largely for the backwardness of the trade. It has accordingly been urged that both a Fisheries Department and Fisheries Act are much needed. Repeated efforts have been made and voluminous reports prepared with a view at least to secure for each province a special Act to protect its fisheries (see p. 546). The multifarious vested interests of a vast population of semi-educated people are the excuses for existing defects. It has been said that when the people have come to appreciate the value of measures to secure and protect their interests, then will be the time for special legislation; and further, that without a proper Act a Fisheries Department would have little justification for its existence. On the other hand, the claims of the fish-curing industries have already been recognised by the organisation of Government fish-curing yards where cheap salt may be supplied, under regulations that ensure its being restricted to the purpose intended, and these have been placed under the control of the Salt Department. But in the annual publication *Financial and Commercial Statistics of British India*, no factory or establishment that employs less than 25 persons permanently is recognised, hence the bulk of the fish-curing yards are excluded. Fish-curing in India, though important in the aggregate, is a domestic rather than a public concern. Nevertheless, in the publication mentioned, there were recorded 10 companies in 1901, 15 in 1903, and 13 in 1904, employing on the average about 1,300 persons annually. These were entirely in the Madras Presidency. In 1882 the prohibition against the use of natural saline earth in the preservation of fish was issued. This of necessity led to some provision to replace that material and method of fish-curing. This was met by the Salt Department concerning themselves with the provision of the fish-curing yards to which reference has been made. The salt issued to the fish-curers was at first given at cost price, but in consideration of the fact that the saline earths formerly employed were procured for the cost of collection, the salt was reduced to 6 annas 8 pies per maund (say 6½*d.* for 80 lb.). It was found, however, that all forms of salt were not equally serviceable for fish-curing; accordingly for some years complaints were general, and a decline in fish-curing having occurred, this was pointed to as a direct result of the Government's efforts at protecting its salt interests while at the same time raising the standard of fish-curing in India. This subject will be found dealt with in some detail by Thurston. [*Bull. Mad. Mus.*, 1900, No. 2, 147–52.]

Number of Yards.

Amount Cured.

Proportion of Each Kind.

From the reports of the Madras Salt Department we learn that 136 curing yards had been organised at convenient centres along the west and east coasts of the Presidency. In 1902–3 the total amount of fish brought to them to be cured came to 50,374 tons, as against 68,992 tons in the previous year. The production came to 814,716 maunds of cured fish, of which it is stated 631,277 maunds were consumed in the Presidency. Thurston gives the returns of the three most important fish as follows:—Sardine, 387,300 maunds in 1896, 253 600 maunds in 1897, and only 31,000 maunds in 1898; Mackerel for these same years, 253,857, 90,035, and 401,946 maunds respectively; and *Seir*, 12,388, 24,321, and 8,088 maunds respectively. It would appear that from 60 to 65 per cent. of the South Indian fish-curing is done in the Salt Department Sub-Division of Calicut (including Malabar and South Canara), such as Calicut, Cannanore, Mangalore and Malpe, etc. There are several other important centres such as Chicacole, Tinnevelly, Cocanada, Chingleput, Nellore, Negapatam, etc. Malpe is interesting as the centre to which the fishermen of Ratnagiri and Goa come for the *seir* fishing season. [*Cf. Memo. prepared by Finance and Commerce Dept. Ind. on the Salt Dept.*, Sept. 1894, 42–3.]

Official Statistics.

The internal traffic in fish, as in most other Indian commodities, can alone be studied by the perusal of the official statistics of Foreign and Coasting Trade. Fish do not appear in the returns of *Rail and River-borne Traffic*, so that very little can be learned of the internal transactions. The following are the headings under which they are recorded:—(*a*) Fish-maws and Shark-fins; (*b*) Fish, Dry Unsalted; (*c*) Fish, Dry Salted; (*d*) Fish, Wet Salted; and (*e*) Fish-oils.

Imports.

Exports.

Trade in Fish-maws and Shark-fins (see p. 542).—India IMPORTS on an average 5½ lakhs of rupees' worth. These come from Aden, Arabia, Mekran and Sonmiani, Persia and Zanzibar. The highest record during the six years ending 31st March, 1907, was in the year 1901–2, when the imports stood at 1,797,114 lb., valued at Rs. 6,58,200; of that amount Bombay took 1,755,877 lb., valued at Rs. 6,27,554, and the balance went to Sind, Madras and Burma. The imports during the years 1903–7 have been:—1903–4, 1,588,692 lb., Rs. 5,87,444; 1904–5, 1,330,326 lb., Rs. 5,05,193; 1905–6, 1,388,365 lb., Rs. 5,25,394; and 1906–7, 1,215,972 lb., valued at Rs. 4,84,465. Practically the entire imports are re-exported, and from 6 to 14 lakhs of rupees' worth of Indian produce exported at the same time. This may approximately be said to represent on the average a total EXPORT traffic of 20 lakhs of rupees in value. Thus, taking the year 1903–4, the foreign shark-fins and fish-maws re-exported came to 1,878,342 lb., valued at Rs. 14,36,580, and the exports drawn from Indian supplies came to 481,873 lb., valued at Rs. 5,14,006; and in 1906–7 the re-exports came to 1,350,020 lb., Rs. 11,73,345, and the exports 565,435 lb., Rs. 5,13,350. Bombay is of course the chief exporting province, and exported out of the totals mentioned, in 1903–4, 1,876,074 lb. foreign shark-fins and fish-maws and 49,520 lb. Indian; in 1905–6, 1,336,804 lb. foreign, but no Indian; but Bombay, however, is by no means the most important exporting centre for the Indian fish-maws and shark-fins. In the Indian produce traffic, Burma usually heads the list, and in 1903–4 exported 281,296 lb., in 1905–6, 243,592 lb.; being followed by Madras with 107,582 lb. and 153,614 lb.; Karachi with 14,923 lb. and 113,804 lb.; and lastly Bengal with 28,552 lb. and 14,768 lb. in the two years mentioned. The most important receiving country is of course

China (Hongkong) for the re-exported fish-maws and shark-fins, followed by the Straits for the Indian. It is perhaps a significant circumstance that the United Kingdom has for some years taken fairly large quantities and even the United States have obtained supplies of these products direct from India.

Coastwise Traffic.

As giving a fuller conception of the Indian production, the following review of the traffic carried coastwise may be framed. In the year 1903–4 the total coastwise transactions came to 1,236,173 lb., valued at Rs.6,84,179, but showed a decrease in 1905–6 to 875,927 lb. Of the amount for 1903–4 Bombay alone took 1,160,667 lb., valued at Rs. 6,29,229. Of these coastwise imports two-fifths came from Madras, one-fifth from Sind, the remaining two-fifths equally from British ports and non-British ports within the Presidency of Bombay. The remainder, over and above the Bombay transactions on total coastwise trade, may be said to be imports taken in 1903–4 by Burma from Madras and Bengal, viz. 47,057 lb. Practically, therefore, the coastwise trade in shark-fins and fish-maws is concentrated in Bombay. It has been fairly constant for some years past, but if anything has manifested a tendency in the foreign imports to decrease and the Indian produce to expand, a satisfactory state of affairs.

Trade in Fish.—(*b*) to (*d*) above may be exhibited as follows :—

Imports.

Foreign Imports.—In 1892–3 the imports of fish were valued at Rs. 28,80,269 (say £193,000). Of that amount the " Unsalted Dry Fish " (see p. 542) came to Rs. 3,55,893, " Salted Dry Fish " (see p. 546) to Rs. 18,08,491, and the " Wet Salted Fish " (*Ngapi*, p. 544) to Rs. 7,15,885. In the years 1894–7 a serious decline took place in the traffic, due, it is believed, to the conditions that then prevailed in Bombay.

ANALYSIS OF THE IMPORTS OF FISH INTO INDIA.

YEAR.	DRY UNSALTED.		DRY SALTED.		WET SALTED (NGAPI).	
	lb.	Rs.	lb.	Rs.	lb.	Rs.
1900–1901	2,324,116	1,14,108	15,765,445	17,68,132	10,549,851	4,31,386
1901–1902	4,253,821	2,26,133	17,253,310	21,63,682	13,411,608	5,34,258
1902–1903	2,963,683	1,79,336	15,089,558	19,71,890	15,896,408	6,03,395
1903–1904	4,742,367	2,48,556	11,837,341	15,35,368	10,688,268	4,38,140
1904–1905	2,879,140	1,60,560	16,339,925	20,37,946	11,204,395	4,59,723
1905–1906	4,192,663	1,94,403	18,088,861	26,56,013	10,903,845	4,36,053
1906–1907	3,889,293	2,59,441	14,404,955	18,98,054	8,711,021	3,86,850

Striking Features of Burmese Traffic.

Another very significant circumstance in the fish trade of India may be stated to be the fact that Bengal practically takes no part in the import traffic. Burma receives by far the major portion of all the fish imported by British India ; and, what is most striking, its supplies come almost entirely from the Straits Settlements, and are uniformly returned at a much higher price than the classes of fish that go to the other provinces. Bombay is the chief receiving province for " Dry Unsalted Fish " and Burma for " Salted Dry " and " Salted Wet Fish." The imports of " Dry Salted Fish " come mainly from the Straits (into Burma) and from Arabia, Mekran and Sonmiani (into Bombay).

Exports.

Foreign Exports.—There exists a small re-export of foreign preserved fish which in 1905–6 came to Rs. 44,584, and in 1906–7, 22,686. But turning from these unimportant transactions to the traffic in Indian produced and preserved fish, it may be said that, if anything, the exports of " Dry Unsalted " and " Dry Salted Fish " from India have shown a tendency to improve during the past decade. In 1892–3, for example, they were valued at Rs. 8,97,406 ; in 1903–4 they came to Rs. 17,75,722 ;

and in 1906–7 to Rs. 15,64,747. The "Dry Unsalted Fish" goes usually in almost equal proportions and value from Bombay and Madras (in 1906–7, the Bombay share came to 1,206,665 lb., valued at Rs. 1,20,490; and the Madras to 4,162,854 lb., valued at Rs. 2,94,235). In the "Dry Salted Fish" trade Madras takes by far the most important position. Out of the total exports of 1906–7, Madras supplied fish of this class to the extent of 9,934,728 lb., valued at Rs. 10,44,465, and these went almost exclusively to Ceylon.

Internal.

Dry Unsalted Fish.

Bombay *versus* Burma.

Dry Salted Fish.

Coastwise Traffic.—But to attain a fairly comprehensive conception of the location and extent of the Indian fisheries, it is necessary to consult the returns of coasting trade. It is unfortunate that no particulars are published of the fish carried by rail and river, as these might have afforded some data upon which to judge of the transactions in the more interior tracts. So far as is known, there are no large fish-curing centres connected with the fresh-water fish and fishing, so that the coastwise traffic may be accepted as fairly representing the local trade. The coastwise transactions are recorded under two headings—"Dry Unsalted" and "Dry Salted." Under each the traffic has fluctuated considerably, but on the whole forward. During the under-mentioned years the "Dry Unsalted" has manifested a satisfactory expansion, *viz.*, Rs. 19,85,869 in 1899–1900; Rs. 29,30,971 in 1903–4; and Rs. 25,61,334 in 1905–6; while the "Dry Salted" have practically remained stationary—Rs. 7,87,774 in 1899–1900; Rs. 7,80,301 in 1903–4; and Rs. 7,50,975 in 1905–6. By far the most remarkable features are the immense traffic towards the town of Bombay in cheap fish, and the fairly large supplies drawn by Rangoon of highly priced fish. Thus, for example, in 1905–6 Bombay imported coastwise "Dry Unsalted Fish" to the extent of 15,040,751 lb., valued at Rs. 6,43,159, and Burma 7,219,489 lb., valued at Rs. 18,10,459. The Bombay town supply was procured from British ports within the Presidency (Rs. 2,92,757); from Kathiawar (Rs. 2,60,698); from Daman (Rs. 66,044); and from "Other Provinces" (Rs. 22,660). The Burma supply was drawn from Bengal (Rs. 5,03,765); Madras (Rs. 7,24,770); "Other Provinces" (Rs. 1,94,453); and from the British ports within the province of Burma itself (Rs. 3,86,946). Turning now to the subject of the coastwise traffic in "Dry Salted Fish," the total for 1903–4 came to Rs. 7,80,301, and in 1905–6 to Rs. 7,50,975. But by far the most remarkable aspect in this traffic may be said to be the circumstance that the exports are almost exclusively into Bombay, Madras and Burma, in equal proportions and from their own provincial ports into their chief towns.

Location of Fisheries.—It may, in conclusion, be inferred, from these observations, that the fisheries of India are mainly along the west coast from Kathiawar to Travancore; that Burma is the least self-supporting of all the provinces and demands from external sources a superior, not an inferior quality of fish; and lastly that Bengal, while it takes very little share in the export traffic in fish, produces apparently enough for its own necessities, since it practically imports no fish either from foreign countries or from other Indian provinces.

D.E.P., iii., 405–7. Fennel.

FŒNICULUM VULGARE, *Gaertn.*; *Fl. Br. Ind.*, ii., 695; *Rec. Bot. Surv. Ind.*, i., 200; iii., 64, 220; Duthie and Fuller, *Field and Garden Crops*, iii., 43, t. lxxxii.; Duthie, *Fl. Upper Gang. Plain*, 394;

Cooke, *Fl. Pres. Bomb.*, i., 572-3; Firminger, *Man. Gard. Ind.* (ed. Cameron), 166; UMBELLIFERÆ. The Fennel, *saunf, bari saunf, sonp, mauri, pan-muhori, bari-shopha, variari, badishep, badisopu, azpa, badyan, sohikire, shombu, pedda-jila-kurra, sa-meit, madhuriká.* A perennial which attains a height of 5 to 6 feet, commonly cultivated throughout India, at all altitudes up to 6,000 feet, and also found wild.

Cultivation. This plant seems to be grown only in small patches, on homestead lands, as a cold-weather crop. Firminger informs us that it thrives well in Bengal, and where once grown will come up each cold season afterwards, from self-sown seed. The seeds should be sown in October on the plains, and in March and April on the hills. Of the United Provinces, Duthie and Fuller intimate that fennel is extensively cultivated during the cold season in garden patches. In Bombay, the chief localities are Khandesh and Gujarat, but it is also grown in the Deccan.

Chemistry. Fennel fruit yields about 3 per cent. of volatile oil, which consists of *anethol* or anise camphor and variable proportions of a liquid isomeric with oil of turpentine. The oil is used in Europe in the manufacture of cordials and enters into the composition of fennel water, which is known in India as *muhori-ka-arak* or *arak bádian.* [*Cf.* Thorpe, *Dict. Appl. Chem.*, 1900, iii., 12; Schimmel & Co., *Semi-Ann. Rept.*, Oct.-Nov. 1897, 27-8; Oct.-Nov. 1902, 42-3.]

Medicine. The fruits and oil are stimulant, aromatic and carminative, used largely as flavouring agents to medicines. The root is purgative and the leaves diuretic. [*Cf. Pharmacog. Ind.*, ii., 1890, 124-7; Dutt, *Mat. Med. Hind.*, 1900, 174; White and Humphrey, *Pharmacop.*, 1904, 203.]

Trade. The exports are not very important. During the five years ending 1903-4 they ranged from 3,355 cwt., valued at Rs. 29,277, to 14,085 cwt., valued at Rs. 1,16,370, but have since declined to 10,974 cwt., valued at Rs. 1,09,735 in 1906-7. Ceylon is usually the most important receiving country, though during 1903-4 and 1904-5 the United Kingdom took the largest amounts, viz. 5,396 cwt. and 10,521 cwt., but in 1906-7 took only 522 cwt. Outside the British Empire, Germany is the only country that need be mentioned. In 1903-4 it took 1,424 cwt., and in 1906-7, 2,272 cwt. Practically the whole of the exports go from Bombay.

G

D.E.P., iii., 464-79.

GARCINIA, *Linn.*: *Fl. Br. Ind.*, i., 259-70; Roxb., *Fl. Ind.*, ii., 618-30; Gamble, *Man. Ind. Timbs.*, 49-55; Cooke, *Gums, Resins, etc., Ind.*, 1874; GUTTIFERÆ. A large genus of evergreen trees of the tropics, none of the species extending to the Panjáb or the United Provinces, and few even to the North-East Himalaya. There are thirty-six species, most of which contain a yellow juice, which generally gives a more or less useful pigment—the grades of Gamboge.

G. Gambogia, *Desr.*; Talbot, *List Trees, etc.*, 1902, 27; Cooke, *Fl. Pres. Bomb.*, 1903, i., 77; Brandis, *Ind. Trees*, 51. The *híla, aradal, manthulli, ponapuli, upagi mara, dharambe, ghorkpulli, gorakkapulli, goraka,* etc. A small evergreen tree of the western coast and Ceylon, ascending to 6,000 feet on the Nilgiris. Gum. It is said to yield a yellow, very adhesive GUM, which is valueless as a pigment because insoluble in water. It is, however, soluble in spirits of turpentine, and thus forms a beautiful yellow VARNISH. Yellow Varnish. It also gives an OIL used in medicine. Oil. The FRUIT is edible and of a pleasant acid taste. Edible Fruit. It ripens during the rainy season. The rind of the fruit is employed as a condiment and eaten with fish as a substitute for tamarind. Timber. The WOOD is grey, sometimes patched with red, smooth and close-grained. Beddome remarks that it would be useful for common furniture. [*Madras Weekly Mail*, May 16, 1901.]

G. Cowa, *Roxb.*: *Rec. Bot. Surv. Ind.*, 1893-1902, i., 56; 1903, ii., 82; Prain, *Beng. Plants*, 1903, i., 247; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 289; Brandis, *Ind. Trees*, 52. A tall evergreen tree with a round stem. It occurs in Bengal, Assam, Chittagong, Burma and the Andaman Islands. In Bengal it is the *cowa*, and in Burma the *taungthalé, ma-dow.* It produces a yellow GUM which is insoluble in water, but with spirits of turpentine gives a beautiful and permanent yellow VARNISH for metallic surfaces. In certain districts the bark is employed to produce a light-yellow DYE used in colouring cloth for the garments of Buddhist monks. Duncan (*Dyes and Dyeing, Assam*, 1896, 25) mentions that its use in dyeing is unknown in that province. The FRUIT ripens at the beginning of June, and is of the size and form of a small orange. It is acid in taste, but otherwise good, and makes a very fine preserve. The WOOD is not used for any economic purpose.

Gum.
Yellow Varnish.
Dye.
Fruit.
Timber.

G. heterandra, *Wall.* An evergreen tree of the hills of Burma up to 3,000 feet. It is the *thanattaw* or *tha-nat-tau*, and yields a superior quality of gamboge sometimes called Arakan. [*Cf.* Hanbury *Journ. Agri.-Hort. Soc. Ind.* (*Proc.*), 1859, x., 121.] A sample from Tavoy, when analysed, gave:—resin 76·5 per cent.; gum 23·5. [Gamble, *l.c.* 55.]

Arakan Gamboge.

Kokam Butter.

G. indica, *Chois.; Rec. Bot. Surv. Ind.*, i., 53, 56; Nairne, *Flowering Pl. W. Ind.*, 1894, 25; Woodrow, *Gard. in Ind.*, 1899, 174–5; Cooke, *Fl. Pres. Bomb.*, 1903, i., 76; *Kew Mus. Guide*, 1907, 21; Kokam Butter, Mangosteen Oil or Brindonia Tallow Tree, *kokam, ratambi, amsúl, bhirand, katambi, bhirandel, múrgal mara, dhupadi-enné, murinahuli, brindáo*, etc.

This slender tree with its drooping branches is found in the forests of the Konkan, Kanara, Coorg and Wynaad, and is often planted, especially in the southern districts of the Bombay Presidency. It thrives particularly well on the lower slopes of the Nilgiris, and a writer in *Indian Gardening* (March 16, 1899, 108) recommends its cultivation for the fruit as a by-product on lower elevation estates. From the SEEDS of the fruit a valuable OIL is extracted known as *kokam* butter. It is obtained in one of several ways by boiling, churning, or simply pressing the seeds in an ordinary oil-mill. In the Indian bazárs it is found in the form of egg-shaped or oblong lumps, of a whitish colour, at ordinary temperatures, firm, dry and friable, yet greasy to the touch. Examination of the glycerine under the microscope proves it to be crystalline. Usually it contains a considerable amount of impurity, but by filtration it may be obtained perfectly pure, transparent, and of a light-yellow colour. It melts at 98° F. According to Flückiger and Hanbury it contains stearic, myristic and oleic acid. In medicine it is considered nutritive, demulcent, astringent and emollient. It is also used as a substitute for cod-liver oil, and in the preparation of ointments. The FRUIT, sometimes called the wild mangosteen, has long been considered an article of food. Garcia de Orta (1563) refers to it under the name of *brindols*, and in his note on Linschoten's account of Indian fruits Paludanus (1596) calls it *brindoijus* and speaks of its sour taste—it is called *brindao* in Goa to-day. Woodrow mentions that a statement made by Graham in the *Bombay Courier* (June 12, 1830), to the effect that it is used at Goa for adulterating *ghí*, had been denied by a writer in *The Indian Times*. At the present day the dried fruit is used as a condiment in curries, and in the preparation of acidulous drinks. A considerable trade in *kokam* butter is carried on by the Goanese. [*Cf. Pharmacog. Ind.*, 1890, i., 163–7; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 45–6; Andés, *Veg. Fats and Oils*, 1897, 216, 218; Waring, *Baz. Med. Ind.*, 1897, 83–4; Wright, *An. and Veg. Fixed Oils, Fats, etc.*, 1903, 299, 353; *Imp. Inst. Tech. Repts.*, 1903, 128, 132.]

Seeds.
Oil.
Fruit.

Mango-steen.

G. Mangostana, *Linn.;* Nairne, *l.c.* 25; Woodrow, *l.c.* 173; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 289; *Kew Mus. Guide*, 1907, 21. Mangosteen, *mangústan, mustah, mengkop, mimbu, youngzalai, manggis.* An evergreen tree of the Malay Peninsula, indigenous to the Molucca Islands. [*Kew Bull.*, 1898, 26.] Fairly extensively cultivated in Burma (Tenasserim) and in a few special localities in India, such as the Barliár gardens, Nilgiri hills.

Though frequent efforts have been made in Bengal and Western India to grow this tree, it has not been known to fruit successfully. In Ceylon, Trinidad and Jamaica better results appear to have been attained. A warm moist, insular climate seems essential to success. In the open plains it does not thrive so well as in valleys with light shade. Is liable to the disease known as gamboge canker.

Yield.

Fruit sent to England.

Preserved.

It is propagated by seed, grafting or inlayering, and on rich loamy, well-drained soils. The tree is commonly said to begin to bear when from 7 to 10 years, or, according to other experience, not until it is 15 to 20 years old. It may continue to yield thereafter for 50 to 100 years. The fruiting season is June to September. Rich cultivation is essential, such as manure once a year. Care must also be taken in picking the fruit, since until the rind has hardened it is delicate—a fall may often be fatal to any idea of preservation. The yield has been variously stated. A writer in *Indian Gardening* speaks of trees planted 25 by 25 feet yielding 1,000 fruits an acre, with a net profit of £2. A writer in *The Planter*, on the other hand, affirms that each tree may give an annual income of £2 to £5. Gamble observes that according to Helfer one tree may yield 1,000 fruits yearly, valued at Rs. 3 per 100. At Barliár a tree has been reported to have given 1,200 fruits. The fruits are usually strung by a bast fibre, being tied between the thick, hard, calyx teeth and the fruit; bunches thus formed are hung up to mature. If intended to be transported, these bunches should be packed in baskets along with wet moss, and dispatched the day they are plucked. Some years ago a consignment of fresh fruits was sent to London from the West Indies, but apparently no trade has as yet been organised. As an article of food, the fruit is highly esteemed both by Europeans and Natives, and is considered by many persons the most delicious of Eastern fruits. Ships coming from the Straits bring it to Rangoon and Calcutta, but by the time they reach the latter port the fruits have lost their true flavour, and are often very bitter, through the formation of layers of yellow gamboge between the pips. A considerable trade is done, however, and the price ranges from Rs. 3 to as much as Rs. 10 a hundred, according to season and quality. Recently an attempt has been made to preserve the mangosteen, and a little more enterprise might make this an important industry. Traffic in mangosteen is, in fact, very ancient. Tavernier (*Travels Ind.*, 1676 (ed. Ball), ii., 287) speaks of the fruit as abounding in Siam.

Tanning Materia

The rind is a powerful tanning material, and an attempt has been made to utilise the immense quantities available in Burma and the Straits. [*Cf. Agri. Ledg.*, 1902, No. 1, 14.] The chemistry of the rind was investigated by Schmidt in 1855. It contains tannin, resin, and a yellow crystallisable principle, *mangostin*. In medicine the rind or entire fruit is employed in the production of a syrup that is used in chronic diarrhœa and dysentery. [*Cf. Pharmacog. Ind.*, i., 167; *Yearbook of Pharmacy*, 1892, 167; 1900, 399; *Settl. Repts. Amherst*, 1893, 47; *Cult. in Singapore, Agri. Bull. Straits*, 1902, i., 373; Nisbet, *Burma under Brit. Rule and Before*, 1901, i., 352; *Hawaiian For.*, 1905, ii., 91; *Trop. Agrist.*, 1905, xxv., 259–60.]

Gamboge.

G. Morella, *Desr.;* Talbot, *List Trees, etc.*, 1902, 27; Cooke, *l.c.* 77–8; Gamble, *l.c.* 55; Brandis, *Ind. Trees*, 1906, 53. Indian Gamboge Tree. The vernacular names may be thus grouped:—the tree—*arsinagurgi mara, aradal, punar puli, kankutake, daramba, tha-men-gút:* the resin—*ghótághaubá, ausaraherevan, revachinnisírá, makki, ireval-chinip-pál, sanato-sí, rubbireránd, farfiran,* etc. An evergreen tree of the forests of the Khasia hills, Eastern Bengal, the West Coast and Ceylon. The Gamboge of European commerce comes from Siam, and is obtained from *G. Hanburyi, Hook., f.* (*Kew Mus. Guide*, 1907, 20).

Gum-resin.

Tapping.

Pipe Gamboge.

From the GUM-RESIN is produced the gamboge of medicine and the arts. That substance has been known almost from classic times. Of European writers it was first mentioned apparently by Clusius (1605). It is referred to in Chinese works as far back as the end of the 13th century. The gum is not collected to any material extent in the forests of India, and the chief supply comes, therefore, from Siam. Before the resin can be gathered, the trees must be some ten years old. Tapping is carried on during the rainy months, June to October, when the sap is vigorous, by cutting a spiral line round the trunk from a height of about ten feet above the ground. Down these grooves the resin trickles in a viscous stream into hollow bamboos placed at the base. From these it is decanted into smaller bamboos, and left for a month or so to solidify. To remove the gamboge the bamboo joints are placed over a hot fire, which causes them to crack, when a round stick of gamboge is obtained from each—the Roll or Pipe Gamboge of commerce. This method does not seem to be employed in India, where only

Cake and Granular. Pigment. Composition. Prices.

small incisions as a rule are made, and the resin collected in small tear-drops. In Ceylon it is procured by cutting here and there a thin slice off the bark and scraping away the resin which collects on the exposed surface. Cake and Granular Gamboge are thus obtained, but both these are less pure than Siam pipe gamboge. The best commercial samples of the pipe gamboge are of a rich brown colour externally, dense and brittle, with a conchoidal fracture of a reddish-yellow colour, odourless and tasteless at first, then acrid. Mixed with water it forms a yellow emulsion. Hurst (*Painters' Colours, Oils, etc.*, 1901, 461) gives an account of the chemistry. Analysis shows it to contain :— moisture, 2·50 per cent. ; mineral matter, 1·05 ; resin soluble in ether, 66·05 ; wax soluble in alcohol, 4·31 ; gum, 26·03. Gamboge dissolves in ammonia with a yellow colour, and this solution produces yellow and red dyes with zinc, alumina, and lime mordants. The average London quotation for Siam gamboge varies from about £6 10*s*. to £10 per cwt.

Medicine. Oil.

In MEDICINE, gamboge is employed as a hydragogue and drastic cathartic and anthelmintic. From the seeds a semi-solid OIL or fat is obtained, used as a lamp-oil or a substitute for *ghí*. [*Cf.* Milburn, *Or. Comm.*, 1813, ii., 507 ; Cooke, *Gums, Resins, etc.*, 1874, 41–4, 46–8 ; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 43–4 ; *Pharmacog. Ind.*, 1890, i., 168–70 ; *Trop. Agrist.*, 1895–6, xv., 216–7, 319 ; *Yearbook of Pharmacy*, 1897, 177–8 ; 1899, 164–5 ; Livache, *Manuf. Varnishes, Oil Crushing, etc.*, 1899, 77–8 ; Moritz Lewinthal, *Ueber das Gummigutti*, 1900 ; *Chem. and Drugg.*, 1901, lix., 102 ; Allen, *Comm. Organ. Anal.*, 1901, iii., pt. i., 461–3 ; Barry, *Legal Med. Ind.*, 1902, i., 532, 558 ; Mitchell, *Animal and Veg. Fats, etc.*, 1903, 299 ; Blyth, *Foods*, 1903, 353, 491 ; White and Humphrey, *Pharmacop.*, 1901, 543 ; Tschirch, *Die Harze und die Harzebehälter*, 1906, ii., 833–50.]

G. Xanthochymus, *Hook., f.* ; *Rec. Bot. Surv. Ind.*, i., 336 ; Talbot, *l.c.* 27–8 ; Cooke, *l.c.* 78 ; Prain, *Beng. Plants*, i., 247 ; Firminger, *l.c.* 290. The *dampel, tamál, tepor, manhola, tavir, iwara memadí, mukki, janági, madaw*, etc. A medium-sized evergreen tree of E. Himalaya and E. Bengal ; from Kanara south, through Coorg and the Nilgiris ; also in the N. Circars, Burma and the Andaman Islands.

Inferior Gamboge. Yellow Dye. Fruit.

A large quantity of an inferior gamboge is obtained from the GUM-RESIN of this species. In Assam it is extensively used as a DYE. The Phakials of Lakhimpur also employ the bark to produce a bright yellow. The mordant used is the green leaves of ***Symplocos grandiflora*** (*bhomrati*). [*Cf.* Duncan, *Dyes and Dyeing, Assam*, 1896, 26.] The FRUIT is utilised in medicine either fresh or dried, and also eaten as a FOOD. It ripens in January and February, and is sometimes used in place of the tamarind for preparing curry, and this fruit, as also that of ***G. paniculata***, are used in the preparation of vinegar (see p. 1109).

Gem-Stones.

GEM-STONES.—Holland, *Rev. Min. Prod. Ind.*, 1898–1903, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 106–9 ; also *Imp. Gaz.*, 1907, iii., 160–3. Holland states that the most important of the precious and semi-precious stones of India are amber, jadeite and ruby. "The only precious and semi-precious stones at present mined in India are the diamond, ruby, sapphire, spinel, tourmaline, garnet, rock-crystal, and the various chalcedonic forms of silicon, jadeite and amber" (see p. 64). The Pearl, though not a mineral but an animal gem-stone, may be described here. In the present article, therefore, a classification into MAJOR and MINOR gems may be adopted advantageously. Under the heading of MAJOR GEMS will be taken up in alphabetical sequence—Beryl, Diamond, Pearl, Ruby, Sapphire, Spinel, Topaz and Turquoise ; under MINOR GEMS—Garnet, Jade, Lapis Lazuli, the Quartzose minerals (Rock Crystal, Agate, Onyx, Jasper, etc.), and Tourmaline.

Imports.

Total Trade.—The value of the precious stones found annually in India does not apparently equal the value of the unset stones and pearls imported. The IMPORTS in 1903–4 amounted in value to Rs. 1,52,15,502, and in 1906–7 to Rs. 93,38,103, and came chiefly from the United Kingdom, Arabia, France and Persia. The share of Bengal was Rs. 94,62,278

Exports.

in 1903-4, and Rs. 6,05,482 in 1906-7; of Bombay, Rs. 55,02,591 in 1903-4, and Rs. 84,49,271 in 1906-7. The balance on the totals of the years named went to Burma. In the same years the EXPORTS (Indian merchandise, including Jade) amounted to Rs. 9,25,257 and Rs. 18,81,608, and the re-exports to Rs. 92,118 and Rs. 2,57,598.

I. MAJOR GEMS.

1. **Beryl.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 520-2; Holland, *l.c.* 107-8. The *sabzá, panooa, fastiki kerasi.*

Aquamarine.

Prof. Church writes me that beryl includes not only the rich green emerald, but also the sea-green aquamarine as well as the white, and the bluish varieties of a mineral species, which is a silicate of alumina and another earth, now generally called beryllia.

According to Holland, the palest varieties are common in the granite pegmatites of India, but the crystals are too fissured for use as gem-stones. The only places where attempts have been made to excavate pegmatite solely for its aquamarines are at Padyur (Pattalai) near Kangayam, Coimbatore district, and at different places in the Toda hills in Rajputana. [*Cf.* Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, ii., 138; Tavernier, *Travels*, 1676 (ed. Ball), 1889, ii., 104; Milburn, *Or. Comm.*, 1813, ii., 288; Watt, *Min. Rev. Ind.*, 1894, 16; 1895, 39; 1896, 38; 1897, 36 7.]

D.E.P., iii., 92 101. Diamond.

2. **Diamond.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 1-50; Tavernier, *Travels*, 1676 (ed. Ball), ii., 431-64; *Rec. Geol. Surv. Ind.*, 1889, xxii., pt. 1, 1 2; pt. 4, 282-3; 1890, xxiii., pt. 2, 69-72; pt. 3, 153-6; Holland, *l.c.* 108; also *Imp. Gaz.*, iii., 160-1: Watt, *Mem. Res. Ind.*, 1894, 23 4; *Min. Rev.*, 1894, 16-7; 1895, 39; 1896, 38-9; 1897, 37; *hírá, almás, híráka*, etc.

Sources.—India was the first and for long the only source of diamonds known to European nations, and most of the great historic diamonds, the Koh-i-nur, the Orloff, the Pitt, etc., were obtained from that country. Many of the early Indian explorations by Europeans were primarily conducted with a view to learn particulars of the supply of diamonds and other precious stones. References to Indian diamonds accordingly occur in the writings of most of the early travellers. Marco Polo wrote of them in the 13th century. Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 1863, 107) deals specially with the diamonds of Cambay. The history of the Koh-i-nur, given by Tavernier (1676, *l.c.* 123-7), traces that gem back to the time of the Emperor Baber (*Memoirs* (Leyden and Erskine, transl.), 308). Jahangir (*Memoirs* (Price, transl.), 2-3, 51) gives an account of the diamonds in the crown and throne used by him. Garcia de Orta, who was in India in 1563 (*Coll.*, xliii.; also in Ball, *Proc. Roy. Ir. Acad.* (3rd. ser.), 1890, i., 657-61) mentions various Eastern diamond mines, such as that of "Bisnager" (Vijayanagar) and the "Decam" (Deccan). Ball, in his translation of Tavernier's *Travels*, gives full particulars of all the Indian sources of diamonds, and the reader desirous of such details should, therefore, consult that work (app., 431 61). Tavernier—a diamond merchant—was the first European to critically examine the diamonds and the Court jewels of India. His work is, accordingly, highly instructive. Fryer (*New Acc. E. Ind. and Pers.*, 1675, 188, 212-4) and Thevenot (*Travels in Levant, Indostan, etc.*, 1687, pt. iii., 98-100, 104) speak of the diamonds of Golconda, etc. (Golconda mines, consult Ball, *l.c.* 453-6). Milburn (*Or. Comm.*, 1813, ii., 79-81) furnishes particulars for the guidance of the purchaser and enumerates the more important historic diamonds that had been procured from India up to the beginning of the 19th century.

Production.

Three Groups.

The following account by Holland gives concisely the chief facts of the modern production:—"Notwithstanding the reputation (stretching back even as far as Ptolemy in the European, and further in the Hindu, classics) which India has had as a diamond-producing country, the output of to-day is very small and comparatively unimportant. The places which, according to accounts, have been most productive in the past form three great groups, each in association with the old unfossiliferous rocks of probably pre-Cambrian age, now known as the Purána group, and distinguished locally as the Cuddapah and Karnul systems in South India, and as the Vindhyan system in the northern part of the Peninsula. The southern of the three groups of diamond-occurrences includes localities, with apparently authentic records, in the districts of Cuddapah, Bellary, Karnul, Kistna, and Godavari. Loose stones have been picked up on the surface of the ground, found in deposits of alluvium and in the workings which have been undertaken in the so-called Banaganpilly stage of the Karnul series of strata. In the second group of occurrences, in the Mahanadi valley, the stones have been found in the alluvium of the Sambalpur and Chanda districts, and though strata similar to those of the Vindhyans and Karnuls are known in this area, no diamonds have been found in these older rocks. The third group of occurrences occupies a tract some sixty miles long by ten miles wide, with the Vindhyan conglomerates near Panna as the centre. The diamond-mining industry still persists in this area, both in the old conglomerate of Vindhyan age, and in deposits which, though described as alluvium, are possibly relics of Lameta (Upper Cretaceous) deposits."

Southern.

Mahanadi.

Panna.

The diamond, on account of its hardness, has for long been made use of for glass-cutting purposes. A rude variety, known as Bort, has been chiefly employed in this way. In medicine, diamond dust is known to be a powerful mechanical poison. [*Cf.* Hodges, *Diary*, 1681–7, iii., cxxv., *et seq.*; Heyne, *Tracts on Ind.*, 1814, 92–107; Bernier, *Travels*, 1656–68, app., 469–71; King, *Ind. Agri.*, Nov. 1892; *Madras Weekly Mail*, Dec. 13, 1900, 562; The Pitt Diamond, confer Walter Fitz-Patrick, *Rept. Hist. MSS. Comm.*, 1892; Brough, *Mining of Non-Metall. Min.*, in *Journ. Soc. Arts*, Jan. 15, 1904, 168–72.]

Industrial Uses.

Mechanical Poison.

3. **Pearls, Pearl Fisheries and Mother-of-pearl.**—Pearls are found in several molluscs which inhabit shallow seas and sandbanks in both the Old and New Worlds. The most productive is the so-called "Pearl Oyster," in reality a mussel—***Meleagrina margaritifera***, *Lam.* Modern classification, however, favours its reduction to ***Avicula***; *moti*, *mutti*, *muthu*, etc.

D.E.P., vi., pt. i., 117–22. Pearls.

Formation.—It is now known that most pearls are formed by the presence of some foreign substance, which becomes embedded in the interstices of the molluscan mantle and constitutes a source of irritation. This irritation causes the mollusc to deposit nacreous matter in concentric layers until the foreign particle becomes completely encysted. It has been practically established, chiefly through the investigations of Dr. Lyster Jameson, that the irritating substance which induces the pearl-formation is very seldom a sand grain, but almost always a small parasite, in some cases a simple protozoan, in others one of the stages in the life history of a flat worm. Prof. Herdman of Liverpool, who was requested to examine the fisheries in the Gulf of Manar, states in his report that the majority of the best pearls contained as their nuclei the remains of certain Platyhelminthian parasites, which he identified as the larval condition of a Cestode or tape-worm. This cestode passes from the body of the pearl oyster into that of a file-fish and from the file-fish into some larger animal, possibly the large Trygon or ray.

Parasitic Action.

Though pearls originate in the mantle, they nevertheless, when large, frequently work their way out and lie loose between it and the shell, or become attached by subsequent nacreous deposit to the "mother-of-pearl" surface of the latter. In this position a pearl may become so covered up as to form a hemispherical mass which when cut out forms the "perle bouton" of the jewellers. The hollow warty pearl, known as "blister pearl," is produced by a deposit of nacre in order to close an aperture arising from some injury.

Formation.

Blister Pearls.

Indian Fisheries.—The pearl fisheries of India have been famous from remote times. Garcia de Orta in 1563 (*Coll.*, xxxv.) mentions the principal localities in the Persian Gulf where pearls were then obtained and says the pearls were cleaned and polished with pounded rice and salt. Linschoten in 1598 and Tavernier in 1676 describe both the Persian and the Ceylon pearl fisheries. At the present time the largest pearl fisheries in the East are those of Ceylon, for information concerning which the reader should consult the reports submitted to the Government of Ceylon in 1904 by Prof. Herdman, Mr. J. P. Lewis and Mr. Hornell; also Herdman's much fuller report published by the Royal Society (London, 1903–6, 5 vols.). In 1905 the total amount realised was Rs. 25,10,621, and the number of oysters fished up 49,250,189. These fisheries (it is understood) have been recently sold, or rather leased, for £20,000 a year to a company who are to work them. The only other pearl fishery of importance

Fisheries.

Ceylon.

Returns.

is that of the Mergui district, Burma, which forms a considerable source of revenue to the Burma Government.

Mother-of-pearl.

MOTHER-OF-PEARL (see p. 989) is procured in connection with the Pearl and Chank fisheries of South India. It is carried all over the country, but curiously enough is not worked up to the extent that might be anticipated, though a fairly large trade exists in exporting the shells (Watt, *Ind. Art at Delhi*, 1903, 206–8).

[*Cf.* Renaudot, *Acc. Ind. and China by Moham. Trav.* in 9th century (Engl. transl.), 1733, 95–8; Marco Polo, *Travels* (ed. Yule), 1871, ii., 267, 274, etc.; Barbosa, *Coasts E. Africa and Malabar*, 1516 (ed. Hakl. Soc.), 66, 170; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, i., 45; 128; ii., 133; Pyrard, *Voy. E. Ind., etc.*, 1601 (ed. Hakl. Soc.), ii., 143, 239; Tavernier, *Travels*, 1676 (ed. Ball), 1889, ii., 107, etc.; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 29, 109; Milburn, *Or. Comm.*, 1813, i., 357–62; *Paulus Ægineta* (Adams, Comment.), 1847, iii., 473–4; *Burma and Its People* (ed. Theobald), 1882, i., 127; Thurston, *Pearl and Chank Fisheries, Manar, Madras Govt. Mus. Bull.*, i., 1894; *Pearl Fishing, Bassein Dist., Agri. Ledg.*, 1896, No. 36; 1897, No. 1; Twynam, *Rept. Ceylon Pearl Fishery*, 1900, 1–66; Donnan, *Insp. Pearl Banks, Trop. Agrist.*, 1901, xxi., 243–5; E. im Thurn, *Ceylon Pearl Fishery*, Jan. 1904, xxiii., 443–5; Feb., 507–9, etc.

D.E.P.,
vi., pt. i.,
584–9.
Ruby.

4. **Ruby.**—Ball, *Man. Econ. Geol. Ind.*, iii., 427, etc; Fritz Noetling, *Note on Rept. Namseka Ruby Mine, Mainglon State*, in *Rec. Geol. Surv. Ind.*, 1891, xxiv., pt. 2; Holland, *Rev. Min. Prod. Ind.*, vi., 584–9; also *Imp. Gaz.*, iii., 161. The *lal, manak, kembu, yákut remáni*, etc.

Oriental.

This name is applied by lapidaries and jewellers to two distinct minerals, the True or Oriental Ruby and the Spinel-ruby (see opposite). The former is a clear, crystalline form of alumina, coloured by some metallic oxide, chiefly that of chromium or of iron, while the latter is an aluminate of magnesium. In hardness the true ruby is inferior only to the diamond, a fact which affords the simplest test for distinguishing it from spinel, but it is also denser and dichroic.

Burma.

Early Records.

Sources.—Rubies have been found in certain localities in Southern India, Ceylon, Afghanistan and Badakhshan, but the chief sources both of the Oriental and the spinel ruby are in the mines of Upper Burma. Garcia de Orta (1563, *Coll.*, xliv.; also in Ball, *Proc. Roy. Ir. Acad.* (3rd ser.), 1889–91, i., 665) gives some account of rubies, but remarks that under the name of "ruby" a great many stones are placed. Ball, commenting on Garcia, says that definite information of the occurrence of true rubies in India, at least the existence at any time of regular mines, is wanting. Tavernier makes numerous references to the ruby, and Ball in his edition of that work (1889, ii. (app. v.), 465–70) takes the opportunity to give a full account of the ruby mines of Upper Burma which should be consulted by the reader.

Mining.

Concession.

Production.

Returns.

Mining.—At the present day ruby mining in India is confined to the province of Burma, the most important locality being near Mogok. Here the rubies occur in a clayey mass, an alteration product of a coarsely granular marble. According to Mr. Bennet Brough, the methods of mining in Burma are suited to the three conditions of its occurrence, in the limestone, in hill detrital material, and in the alluvial deposits in the valleys. The following account is taken from Holland. "During the period under review the ruby-mining industry in Upper Burma underwent a new and favourable phase, the mineral having become, next to petroleum, the most profitable source of revenue among the Burmese minerals. Various leases were granted in the ruby-bearing area near Nanyaseik in the Myitkyina district, and in the 'stone-tract' of the Sagyin hills, in Mandalay district, and the results have been most profitless; but the returns for the Mogok area, where the Burma Ruby Mines Company is paramount, show that the industry has entered a most encouraging phase. The Company was granted the right in 1889 to mine for rubies and to levy royalties from persons working by Native methods, the lease being renewed in 1896 for fourteen years, at a rent of Rs. 3,15,000 a year plus a share of the profits. The result being, however, unsatisfactory from the shareholders' point of view, the rent was reduced in 1898 to Rs 2,00,000, the share of the profits being at the same time raised from 20 to 30 per cent. A dividend of 5 per cent. was paid for the first time in 1898, when the value of rubies obtained amounted to £57,950. In 1899 the Company obtained rubies to the value of £90,848, and paid a dividend of 12½ per cent.; in this year three unusually valuable stones were found, one of 77 carats being valued at 4 lakhs of rupees (£26,666). In the following year (1900) the value of the stones raised increased to £97,326, and the Company paid a dividend of 17½ per cent. The year 1901 showed the record output of stones, valued at £104,476, whilst in 1902 they brought £86,895. In the last year (1903) the Company's receipts were £98,575, and profits on the year's working £44,950." [*Cf.* Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 1866, 168; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, i., 80, 97; ii., 138–41, 151–4; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 112; Ovington, *Voy. Suratt.*, 1689, 201, 585; Milburn, *Or. Comm.*, 1813, i., 360; ii., 288–9; Oldham, *Man. Econ. Geol. Ind.*, 1893, 45; *Min. Rev. Ind.*, 1894, 18; 1895, 41; 1896, 40–1; 1897, 39–40; *Rept. Rev. and Admin., Burma*, 1895–6, 98–9; Ward and Judd, *Proc. Roy. Soc.*, 1895, 57, 387–94; Max Bauer, *Jahrb. f. Min.*, 1896, ii., 197–238; Scott, *Gaz. Upper Burma and Shan States*, 1900, ii., pt. 1, 213–7; 1901, pt. 2, 144, 342, 392; Bennet Brough, *Mining of Non-Metall. Min.*, in *Journ. Soc. Arts*, Jan. 15, 1904, 172–3.]

5. **Sapphire.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 429; Latouche, *Sapphire Mines of Kashmir*, in *Rec. Geol. Surv. Ind.*, 1890, xxiii., pt. 2; Middlemiss, *Sapphirine-bearing Rock from Vizagapatam*, 1904, xxxi., pt. 2, 38–42; Holland, *Rev. Min. Prod. Ind.*, 1905, xxxii., pt. 1, 109. The *nilam, kabúd, neela-hgmet-kha, ouk thapha-ya*, etc. **D.E.P., vi., pt. ii., 473-5. Sapphire.**

Sources.—The sapphire is a transparent variety of corundum or native alumina, composed of oxide of alumina with traces of other substances to which its colour is due. The colour varies from the palest blue to deep indigo, while violet, yellow and green varieties are also met with. Both dark and light varieties are described by Garcia de Orta (1563, *Coll.*, xliv.), who says the latter are called *safira de agua* (water sapphire) and that both varieties are found in "Calicut, Cananor and in many parts of the kingdom of Bisnager." Ball (Rev. of Garcia de Orta, in *Proc. Roy. Ir. Acad.*, 1889–91 (3rd ser.), i., 664), commenting on this subject, states that he has no definite information as to the former workings of sapphire deposits in India. In recent years the chief source of sapphire was at Zanskar in Kashmir, but the mines are now said to be exhausted. According to Holland (*l.c.* 109), the normal blue sapphire and rarer green, yellow and white varieties are occasionally found in the ruby-bearing gravels of Burma. [*Cf.* Tavernier, *Travels*, 1676 (ed. Ball), 1889, ii., 102, 465, 470; Thevenot, *l.c.* 99; Lawrence, *Valley of Kashmir*, 1895, 60–1; *Min. Rev. Ind.*, 1895, 41; 1896, 40; 1897, 40; Bennet Brough, *l.c.* Jan. 14, 1904, 172.] Composition. **Kashmir.**

6. **Spinel.**—Ball, *l.c.* 429–31; Holland, *l.c.* 109. **Spinel.**

The spinel or Balas ruby differs from the true Oriental ruby by containing a considerable percentage of magnesia with traces of chromium and iron oxide. In hardness it is also inferior to the true ruby, of which it is a constant associate and for which it is frequently mistaken. [*Cf.* Tavernier, *l.c.* ii., 102, 467.]

7. **Topaz.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 530–1. **D.E.P., vi., pt. iv., 70. Topaz.**

A fluo-silicate of alumina always containing a little essential water, and occurring only in metamorphic rocks or in the veins which traverse these. Of its occurrence in India there seems no authentic record. [*Cf.* Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, i., 80; ii., 138; Tavernier, *l.c.* ii., 129, 449.]

8. **Turquoise.**—Ball, *l.c.* 435. **D.E.P., vi., pt.iv., 204. Turquoise.**

The existence of the true turquoise in India is doubtful. Holland remarks that its only importance lies in the fact that India is one of the channels by which the material procured in Persia and adjoining areas reaches the European and Eastern markets. The art of manufacturing and colouring imitation turquoise has become a science with the traders in these stones. Recently a new industry has arisen in Kashmir in ornamenting metal wares with a layer of false turquoise embedded over the surface (Watt, *Ind. Art. at Delhi*, 1903, 50, 75). [*Cf.* Linschoten, *l.c.* ii., 141; Tavernier, *l.c.* ii., 103; Milburn, *Or. Comm.*, 1813, ii., 543; Bennet Brough, *Mining Non-Metall. Min.*, in *Journ. Soc. Arts*, Jan. 14, 1904, 174.]

II. MINOR GEMS.

9. **Garnet.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 521–4; Holland, *Orig. and Growth of Garnets, etc.*, in *Rec. Geol. Surv. Ind.*, 1896, xxix., pt. i., **Garnet.**

20–30; also *Rev. Min. Prod. Ind.*, 1905, xxxii., pt. i., 108–9. The *yáqút, chunri, mehtab.*

Composition.

Garnets are silicates of alumina, iron, lime, magnesia or similar bases. They may be grouped in six sections as alumina-lime, alumina-magnesia, alumina-iron, alumina-manganese, iron-lime and lime-chrome garnets.

Supply.

Sources.—The garnet is common in various localities in India, those of Rajputana being the most important. Some stones from Rajputana are said to measure a quarter of an inch to six inches in diameter, and are reputed to be the best in the world. In the Madras Presidency they occur in Vizagapatam, Godavari, Trichinopoly and Tinnevelly, and are fairly abundant in Burma.

Workings.

According to Holland, "The only garnets worked to any considerable extent in India occur in the mica schists of Rajmahal in Jaipur, and near Sarwar in the adjoining State of Kishengarh. Returns are not available to show the condition of the industry in Jaipur, but there is still a considerable industry in the Kishengarh State, though the yearly estimates are altogether too variable to permit of a fair average being drawn, varying from about £10,000 to £2,000."

Jaipur Jewellery.

Cut garnets in the form of necklaces and other small articles of personal adornment constitute an important section of the lapidary craft of India (Watt, *Ind. Art at Delhi*, 1903, 74–5). The chief centre of the production of these goods is Jaipur. The qualities known are the so-called amethystine or

Oriental Garnets.

Oriental garnets, which are usually cut in the form of pendants for jewellery, and the more valuable noble or almandine garnets.

[*Cf.* Garcia de Orta, 1563, *Coll.*, xliv.; Milburn, *l.c.* ii., 288; *Min. Prod. Ind. Rev. and Agri. Dept.*, 1892, 3; *Min. Rev.*, 1894, 17; 1895, 39–40; 1896, 39; 1897, 37–8; *Introd. Chem. and Phy. Study Ind. Min.*, 1895, 81; Scott, *Gaz. Upper Burma and Shan States*, 1901, ii., pt. ii., 230; Bennet Brough, *l.c.* 174–5.]

D.E.P., iv., 535–41. Jade, Jadeite, Jadestone.

10. **Jade and Jadeite.**—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 516–8; Fritz Noetling, *Rept. Econ. Res. of Amber and Jade Mines Area, Upper Burma*, in *Rec. Geol. Surv. Ind.*, 1892, xxv., pt. iii.; *Occurrence in Upper Burma*, 1893, xxvi., pt. i., 26–30; Bauer, *Jadeite from Tammaw, Upper Burma*, 1895, xxviii., pt. iii., 91–5; Holland, *l.c.* 52–4. The *yashm, sang-i-yashab, sútashi*, etc. Under the name Jade several different minerals are included, not always easily distinguishable. True jade or nephrite is a native silicate of calcium and magnesium, and may be regarded as a crypto-crystalline variety of hornblende. Jadeite, commonly confused with true jade, is a silicate of soda and alumina, is harder and has a higher specific gravity and greater fusibility than jade. Both jade and jadeite are of economic importance and are comprised under the general term Jadestone.

Burma.

Sources.—The chief source of the mineral is in Upper Burma. According to Holland, some of the best material is obtained as pebbles in the gravels of the Uru river, a tributary of the Chindwin, but most is obtained by quarrying near Tammaw, in the Mogaung Sub-Division of the Myitkyina district. The jadeite here is enclosed in an eruptive rock closely resembling serpentine which pierces strata probably of Upper Miocene age. No jade (nephrite) of the kind which would be regarded as a marketable mineral is known in India, though a mineral having the essential composition and approaching jade in physical characters is known in South Mirzapur. Outside India it may be remarked that in South Turkestan true jade has been worked for many centuries.

Mining.—The method of extraction is very primitive. Before the discovery of the Tammaw mines, the mineral was obtained only in the form of boulders in the Uru valley, mixed with other rocks in the alluvial deposits of the river. "The boulders are obtained either by digging holes along the bank of the stream or by diving to its bottom. The boulders brought to the surface are at once broken, and the jadeite separated from the useless stuff" (Noetling). In the Tammaw mines the method employed is to heat the surface of the rock by large fires, the fall of temperature by night being sufficient to crack the rock. Crowbars are then inserted in the cracks and the big blocks thus obtained are broken by mallets into lumps of convenient size.

Manufactures.—Jade is highly valued by the Chinese, and also by certain classes in India. The best is of an intense bright-green colour, but red and pale pinkish varieties are also prized. In Burma it is employed chiefly in the manufacture of finger- and ear-rings, bracelets, chains, etc. The chief seat of the manufacture of these articles is at Momein. All sort of cups, vessels, tables and other ornaments are made of it. [*Cf.* Watt, *Ind. Art at Delhi*, 1903, 73, 476–7.] Articles of spurious jade are also frequently met with. The most common of those in India is the Afghan jade-like serpentine, largely used in Bhera (Shahpur district) for making hafts of *peshquabz* (Afghan knives) and of hunting- or ordinary table-knives, small boxes, etc.

Trade.—In Upper Burma the export trade in jade-stone is very considerable. Some passes into South-West China by the overland route, but most finds its way down to Rangoon, whence it is exported to the Straits Settlements and China. During the six years 1897–1903 the exports averaged 3,911 cwt., valued at £44,770, giving an average value per cwt. of £11·45. The exports in 1906–7, according to the Official returns, were 2,998 cwt., valued at Rs. 8,02,270. [*Cf.* Warry, *Rept. on Jade Mines at Mogaung*, 1888 ; *Min. Rev.*, 1894, 17 ; 1895, 40 ; 1896, 39 ; 1897, 38 ; Lawrence, *Valley of Kashmir*, 1895, 65 ; Scott, *Gaz. Upper Burma and Shan States*, 1900, ii., pt. i., 277–89 ; 1901, ii., pt. ii., 268 ; Bennet Brough, *l.c.* 176.]

D.E.P., iv., 587. Lapis Lazuli.

11. **Lapis Lazuli.**—Ball, *l.c.* 528–30. The *lajward, rajavaral.* A mineral of complex composition, but consisting chiefly of silica, alumina and lime. It is commonly known as ultramarine from its blue colour. The mineral powdered was largely used in India for house decoration and book-illumination. [*Cf. Paulus Ægineta* (Adams, transl.), iii., 200–1 ; Linschoten, *l.c.* ii., 144 ; Tavernier, *Travels*, 1676 (ed. Ball), 1889, ii., 156 ; Milburn, *Or. Comm.*, 1813, i., 138.]

D.E.P., ii., 167–75. Quartzose Minerals.

12. **Quartzose Minerals.**—Quartz is the natural silicic anhydride, but hydrated silica also exists. This has led to the classification of the stones of this kind into :—crystallised or phanero-crystalline anhydrous quartz, represented by the rock-crystals; uncrystallised or crypto-crystalline anhydrous quartz, including chalcedony, jasper, agate, etc ; uncrystallised hydrated quartz. The opal is a type of this last group.

(*a*) **Rock-crystal.**—Ball, *l.c.* 502–3 ; Holland, *l.c.* 107. The *bilaur, phatak, tansala.*

Rock-crystal.

Sources.—Rock-crystal is the name given to the transparent varieties of crystallised quartz, the different colours which are met with being due to the presence of small quantities of foreign minerals. These coloured varieties are known by various names, *e.g.* Amethyst, Cairngorm, Rose-quartz, Smoky-quartz, Milk-quartz, etc., and Holland makes the following statement regarding the occurrence of this gem and its use in India :—" In the Tanjore district, Madras Presidency, fragments of rock-crystal are collected and cut for cheap jewellery, being known as " Vallum diamonds," whilst the bi-pyramidal quartz-crystals found in the gypsum of the salt marl near Kalabagh, on the Indus, are to a certain extent used for making necklaces, and rock-crystal is similarly used for cheap jewellery in Kashmir." In *Indian Art at Delhi*, 1903 (*l.c.* 75), it is stated that rock-crystals are also largely cut and made into sword and dagger handles, beads, buckles, necklaces, etc. These are turned out fairly extensively in Jaipur. The so-called " rock-crystal " buckles, etc., of Kashmir are very largely made of paste diamonds. [*Cf.* Mandelslo, *Travels*, in Olearius, *Hist. Muscovy, etc.*, 1662, 83; Tavernier, *l.c.* i., 389 ; Milburn, *Or. Comm.*, 1813, i., 360–1 ; *Min. Prod. Ind. Rev. and Agri. Dept.*, 1892, 3 ; Watt, *Rev. Min. Prod. Ind.*, 1894, 18 ; Nicholson, *Man. of Coimbatore Dist.*, 1898, ii., 150.

Kashmir Jewellery and Ornaments.

Agate and Carnelian.

(*b*) **Agate and Carnelian.**—Ball, *l.c.* 503–4 ; Watt, *Ind. Art.*, *l.c.* 73–5 ; Holland, *l.c.* 107 ; *yamni, manka*, etc.

Agates are concretionary masses or nodules, which occur usually in hollows or veins in volcanic rocks. When cut across, the sections show layers. Their composition consists of 70 to 96 per cent. of silica, with varying proportions of alumina, coloured by oxide of iron or manganese. Various varieties are found, known as Mocha stones, Moss Agates, Bloodstones, Chrysoprase, etc.

Sources.—According to Holland, a considerable trade in agate and the related forms of silica, called *hakik*, still exists. These are obtained from the amygdaloidal flows of the Deccan Trap, chiefly from the State of Rajpipla, where the main source is a conglomerate near the village of Ratanpur. Here the right to collect *hakik* is leased for a period of five years at an annual rental. The most

Cambay Industry.

Murrhine Vases, etc.

Burning and its Effects.

Seasons.

Trade.

important place at which agates are cut is Cambay, but a certain amount of agate-cutting is also carried on at Jabbalpur, and other places within range of the Deccan Trap. They are much used for ornamental and decorative purposes, being made into brooches, rings, seals, cups, etc. The ancient *murrhine* vases, famous from the time of Pliny, are supposed to have been made of agates from Broach and Cambay. While collecting the pebbles the miners divide them into two primary classes—those that are not improved in colour by burning, and those that are. Of the former there are three chief varieties:—(1) the Onyx, known as *mora* or *báwa ghori*; (2) the Cat's-eye, *cheshamadár* or *dola*; and (3) a yellow half-clear pebble called *rori* or *lasania*. All other stones are baked to bring out their colour. During the hot season, generally in March and April, the stones are spread in the sun in an open field. Then in May, a trench, two feet deep by three wide, is dug round the field. The pebbles are gathered into earthen pots, which, with their mouths down and a hole broken in their bottoms, are set in a row in the trench. Round the pots, goat or cow-dung cakes are piled, and the whole kept burning from sunset to sunrise. The pots are then taken out, the stones examined, and the good ones stowed in bags. About the end of May the bags are carried to the Nerbudda and floated to Broach. Here they are shipped in large vessels for Cambay, and offered for sale to the Carnelian dealers.

Colours.

By exposure to the sun and fire, among browns the light shades brighten into white, and the darker deepen into chestnut. Of yellows, maize gains a rosy tint, orange is intensified into red, and an intermediate shade of yellow becomes pinkish purple. Pebbles in which cloudy browns and yellows were at first mixed are now marked by clear bands of white and red. The hue of the red carnelian varies from the palest flesh to the deepest blood red. The best are of a deep, clear, and even red colour, free from cracks, flaws or veins. The larger and thicker the stone, the more it is esteemed. White carnelians are scarce. When large, thick, even coloured, and free from flaws, they are valuable; yellow and variegated stones are worth little. It may be of interest to add in this connection that the burning of agates at Cambay is fully described by Barbosa at the beginning of the 16th century, so that it would appear to be a fairly ancient industry. And moreover other writers of an even earlier date allude to the agates of India without specially indicating their production.

[*Cf* Varthéma, *Travels*, 1510 (ed. Hakl. Soc.), 107; Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 1517, 66–7; Mandelslo, *l.c.* 1662, 26, 40, 83; Tavernier, *l.c.* i., 69; Milburn, *l.c.* ii., 497–9; *Paulus Ægineta* (Adams Comment.), 1847, iii., 476; Campbell, *Bomb. Gaz.*, iii., iv., vii. and xxiii.; Watt, *Rev. Min. Prod. Ind.*, 1894, 17; *Ind. Art at Delhi*, 1903, 73–4.]

Onyx.

(*c*) **Onyx.**—Ball, *l.c.* 503.

The onyx is the general term for those varieties of agate in which the colours are arranged in flat horizontal planes. It is reported to be plentiful in the crystal pits in the Betul district, and to occur near Amerwara in Chhindwara. It was formerly in great repute for cameos, and is employed for various articles of adornment. [*Cf.* Milburn, *l.c.* ii., 515; Watt, *Rev. Min. Prod.*, *l.c.*]

Jasper.

(*d*) **Jasper.**—Ball, *l.c.* 503–14; *Rec. Geol. Surv. Ind.*, 1895, xxv., 202.

A quartzose mineral, commonly of a red or yellow colour. The former occurs among the Cambay stones from the Deccan, and the latter in Tenasserim. A green variety is found in Burma, and fine specimens of ribbon jasper are met with in the Sandur hills, Bellary. [*Cf.* Garcia de Orta, 1563, *Coll.*, xliv.]

Opal.

(*e*) **Opal.**—The *dhúdiá pathar.*

Compact uncrystalline semi-transparent to opaque hydrated silica. There are various varieties, of which the most valued is the Noble Opal, of a milky white colour, opalescent and exhibiting a rich play of colour. [*Cf.* Milburn, *l.c.* ii., 515; Bennet Brough, *Mining Non-Metall. Min.*, in *Journ. Soc. Arts.*, Jan. 15, 1904, 174.]

Cat's-eye.

(*f*) **Cat's-eye.**—The *chush-maidar*, *lasniyán* or *lahsaniya.*

A variety of chalcedonic quartz, presenting a peculiar opalescent reflection, said to be due to the presence of asbestos. It is called Cat's-eye from its resemblance to the eye of a cat, hence also the Burmese name *kyoung*, which has that meaning. [*Cf.* Garcia de Orta, 1563, *Coll.*, xliv.; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), 1885, ii., 141; Milburn, *l.c.* i., 361.]

Tourmaline.

13. **Tourmaline.**—Noetling, *Tourmaline Mines in Mainglon State*, in *Rec. Geol. Surv. Ind.*, 1891, xxiv., pt. ii., 125–8; Holland, *Rev. Min. Prod. Ind.*, 1905, xxxii., pt. i., 109.

Forms of Tourmaline.

A mineral of very complex and variable composition occurring in the granitic and metamorphic rocks of most countries. It is generally black, when it is termed *schorl*; red varieties (*rubellite*), dark-blue (*indicollite*) and white (*achroite*) also occur. The red variety is commonest in India, good specimens being of a deep crimson colour. White specimens have occasionally been found among the black stones from the Shan States, and green tourmaline has been mentioned as occurring in the Hazaribagh district of Bengal and in granite dykes in the bed of the Kauveri, Seringapatam. Holland states that various attempts have been made to work the red variety which occurs in the Ruby district of Upper Burma. In 1898 an outturn worth £359 was reported, in 1900 worth £1,240, and in 1903, £196, but returns for 1898 and 1902 are not available. [*Cf.* Milburn, *l.c.* i., 361–2 ; *Introd. Chem. and Phy. Study Ind. Min.*, 1859, 82 ; *Min. Rev.*, 1895, 42 ; 1897, 40 ; Scott, *Gaz. Upper. Burma and Shan States*, 1900, ii., pt. i., 227–30 ; 1901, pt. ii., 392.]

D.E.P., iii., 503–5. Glass.

GLASS AND GLASSWARE.—Glass is known in India by the vernacular names of *kanch, kunnadi, addanná, shishah, kizaz.* It is a mixture of silicate of potassium or sodium, or of both, with one or more silicates insoluble in water, such as those of the alkaline earths, aluminium, manganese, iron or lead. The mixture is effected by fusion.

Early Knowledge.

History.—Stein (*Ancient Khotan*, 1907, 373), in discussing fragments of glass picked up at Niya (3rd century), observes, "Glass was until the middle of the fifth century of our era known in China only as an import from Ta-Ch'in, the Far West (Hirth, *China and the Roman Orient*, 228 *et seq.*), and it appears very improbable that the introduction of glass manufacture could have been delayed so long, if the making of glass had been an art practised in Eastern Turkestan when the latter was under Chinese control during earlier centuries. It is significant that, according to the *Pei shih*, the first makers of glass in China were traders from the country of the Great Yuik-chih, *i.e.* from the Old Indo-Scythian dominion, for whom the land route through Khotan was a more likely line of communication than the sea route."

Indian Glass.

In India glass is little employed for the purposes it is ordinarily used in other countries (windows, bottles, etc.), and the process of manufacture, as carried on by the Natives, is accordingly very crude and unscientific. The chief materials employed are carbonate of soda in its crude condition, called *reh*, and the impure sands of the rivers with certain special earths, etc. The ordinary Native glass is a coarse, impure, coloured or dirty mass, full of flaws and air bubbles, and suitable only for the manufacture of beads, coarse bangles and other minor articles. White glass is sometimes made (or rather re-made) by melting broken glass or glassware of European manufacture.

Indian Production.—The chief centres of the glass industry to-day are the Lahore, Karnál, Jhelam and Hoshiarpur districts of the Panjáb ; the Bijnor, Lucknow and Saharanpur districts, United Provinces ; Ahmednagar, Kaira and Baroda, Bombay ; Seoni, Central Provinces ; Patna, Bengal ; lastly the State of Jaipur and the North Arcot district, Madras. The chief articles manufactured are bangles (*chúris*), beads, crude globes, silvered with mercury or tinfoil, coarse toys, small bottles, lamp chimneys, etc. The only glassware in India with any pretension to art is that produced at Patna. The articles are generally coloured and the shapes very elegant but exceedingly fragile. The industry is said to be dying out for want of demand. Special mention may be made of the glass mosaics seen in the palaces of some parts of Rajputana, the Panjáb and Burma. It was to meet this demand that the industry of blowing glass globes, silvered inside, sprang into existence. The globes are broken up into fragments of certain sizes, then set in cement (or in Burma in lacquer), and in that way constitute the chief decorative feature of ***shish mahals*** (looking-glass palaces). The smaller fragments of silvered glass are also worked up into the embroidered *phulkari* cloths of the Panjáb. There is in addition the true mosaic art where coloured glass elaborates a pattern, as seen in the palaces of Udaipur.

Bangles. Beads. Patna Glassware.

Glass Works.

The influences that operate against the establishment in India of glass works on a commercial scale are the cheapness of the imported Western products, the want of enterprise on the part of capitalists, and the unfavourable climatic conditions. Recently several praiseworthy efforts to extend the manufacture of glass on a scientific basis have been made; of one of the last, an account is given in *The Times of India* (Oct. 22, 1903). The greatest difficulty is perhaps the apparent absence of a suitable sand for fusing purposes, within easy reach of the trade centres, and of the fuel and other essential materials.

Trade. *Trade in Glass.*—The total IMPORTS into India of glass and glassware of all kinds, including Government stores, were in 1876-7 valued at Rs. 29,45,091; twenty years later (1896-7) they stood at Rs. 72,25,918. For the five years ending 1906-7 they were as follows:—1902-3, Rs. 96,15,634; 1903-4, Rs. 1,01,17,065; 1904-5, Rs. 1,14,21,397; 1905-6, Rs. 1,14,79,658; and 1906-7, Rs. 1,22,75,725. The analysis of the commercial returns (1905-6) might be given as follows:—13,769,052 superficial feet of sheet and plate glass, valued at Rs. 12,44,884; 22,520 cwt. of beads and false pearls, valued at Rs. 24,02,442; 65,785 cwt. of bottles, valued at Rs. 6,50,645; bangles, Rs. 42,78,558; lamp-ware, Rs. 6,94,138; other miscellaneous glassware, Rs. 28,43,441; Government stores, Rs. 1,61,677. Headings. The sheet and plate glass came chiefly from Belgium and the United Kingdom; the beads from Italy, Austria, Germany and the United Kingdom; the bottles from the United Kingdom and Germany; bangles from Austria-Hungary; lamp-ware from Germany, Austria-Hungary and the United Kingdom; and the other wares from Austria-Hungary, the United Kingdom, Belgium and Germany. Bangles and lamp-ware were returned for the first time in 1905-6. In the same year the EXPORTS (Indian produce) amounted to Rs. 98,029. Bombay exported the largest amount, viz. Rs. 89,177, and the chief market was Persia, followed by Turkey-in-Asia, Arabia, Ceylon, Aden and the United Kingdom.

[*Cf.* Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, i., 147-51; iii., 369-73; *Monographs, Pottery and Glassware*:- Halifax, *Panjab*, 1890, 23, 24-7; Taw Skein-Ko, *Burma*, 1894, 5, 13; Maconochie, *Bombay*, 1895, 8-9; Mukharji, *Bengal*, 1895, 10-11; Dobbs, *U. Prov.*, 1895, 29-35, 41-4; Tilly, *Glass Mosaics of Burma*, 1901; *Agri. Ledg.*, 1901, No. 13, 446-7; 1902, No. 5, 125; *Madras Weekly Mail*, Oct. 1, 1903, 365; *Pioneer Mail*, Oct. 2, 1903, 24; Watt, *Ind. Art at Delhi*, 1903, 76, 96-7; Holland, *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. 1, 109-10.]

D.E.P., iii., 509-12. Soy Bean. **GLYCINE SOJA**, *Benth.*, *Journ. Linn. Soc.*, viii., 266; *Kew Rept.*, 1882, 42-3; Prain, *Journ. As. Soc. Beng.*, 1891, lxvi., 403-4; Duthie, *Fl. Upper Gang. Plain*, 232; *G. hispida, Maxim., Duthie and Fuller, Field and Gard. Crops*, 1893, pt. iii., 3, t. 85; LEGUMINOSÆ. (Following the suggestion made by Prain, the above name had better be adopted for the cultivated plant and *G. ussuriensis, Regel & Maack*, for the wild, which = *G. Soja, Sieb. & Lucc.*). The Soy Bean; in Indian vernaculars, *bhat, ram, gari-kulay, hendedisom horec, pond disom, an-ing-kiyo, tzu-dza, bhatnas, seta, musa, khajuwa*, etc.

A sub-erect or creeping annual native of China, Cochin-China, Japan and Java, comparatively recently introduced into India, though recorded as acclimatised and even seen as an escape from cultivation. It might, in fact, be described as extensively cultivated, though more as a garden than a field crop; is especially prevalent in Eastern Bengal, Assam (Barpeta Sub-division), the Khasia hills, Manipur, the Naga hills and Burma. It is not infrequent in the plains of India proper, especially in Busti, Gorakhpur, Patna and Purnea, etc. In Bombay and Madras, however, the Soy Bean has apparently hardly passed the experimental stage.

Cultivation. *Cultivation.*—Two chief varieties occur, one called white, the other black. On the plains it is generally grown by itself as a *kharif* (autumn) crop. The seeds are sown from June to September, and harvested from November to December. They should be placed at a depth not exceeding 1 to 1½ inches, and 18 plants may be left, after weeding, to the square yard. A peaty soil, or one rich in organic matter, is preferred. A good manure for it is sulphate of potash, but nitrogen may be supplied with advantage in the form of nitrate of soda, or in the case of soils poor in organic matter, in the form of rape or mustard cake. In Assam it is sown with *áhu* (autumn rice) in April and May. The *áhu* crop is removed in July and August, and its stubble acts as a support for the bean plants, which are ready for harvest in December and January.

Seasons.

Church (*Food-Grains of Ind.*, 1885, 140–3) gives the following analysis of the bean:—in 100 parts: water 11·0, albuminoids 35·3, starch and sugar 26·0, fat 18·9, fibre 4·2, and ash 4·6. Its chemical composition thus places it above other pulses as an albuminous food. It is eaten in India in the localities where it is cultivated, chiefly in the form of *dál* or *satú*. In Japan it is largely used as a sauce, cheese (*natto*) or paste, and in China an edible oil is obtained from the seed. If cut when the pods are fully formed it makes a most nutritious fodder, and the seed-cake, as already stated, is an extremely rich cattle food. [*Cf.* Milburn, *Or. Comm.*, 1813, ii., 519; *Drug. Bull.*, Feb. 1890, 113; *Trop. Agrist.*, 1893, xiii., 50; 1903, xxiii., 175; King, *Trop. Agrist.*, 1897, xvii., 460; *Ind. Agri.*, March 1, 1899, 93; *Ind. Gard.*, Feb. 9, 1899, 56; *Agri. Ledg.*, 1903, No. 5, 137; König, *Chem. Zusammensetz. der Mensch. Nahr.*, 1903, i., 1484; *Kew. Mus. Guide*, 1907, No. 1, 65.]

Chemistry.

Food.

Fodder.

GOLD.—Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 173–230, 608–10; Mallet, *Man. Geol. Ind.*, 1887, iv., 1; Smith, *Gold Mining in India*, in *Mining Institute*, 1893; Watt, *Min. Rev.*, 1894 to 1897; also *Mem. Res. Br. Ind.*, 1894, 19–20; Bosworth-Smith, *Rept. Kolar Gold-Field and its Southern Extension*, 1889; Grundy, *Repts. Insp. Gold Mines, Mysore State*, 1894, 1895; Hatch, *The Kolar Gold-Field, Quartz-Mining and Gold-Recovery*, in *Mem. Geol. Surv. Ind.*, 1901, 1-90 (numerous plates); Holland, *Rev. Min. Prod.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. i., 10, 12, 45–50. Gold has been known since the most remote classic times of India; it is indicated by the following vernaculars:—*sona, gser, swarna, pwon, bungárum, mas, kanchana, shwae, run, tibr, zahab, tilla, zir*, etc.

D.E.P.,
iii., 519–33.
Gold.

Occurrence.—Gold is known to occur throughout India—in the Bengal, Madras and Bombay Presidencies; in the Central Provinces, Panjáb, United Provinces, Burma and many of the Native States. The ultimate derivation is mainly the quartz reefs which traverse the metamorphic and sub-metamorphic series of rocks, but smaller quantities appear to exist in certain chloritic schists and quartzites and possibly also in some forms of gneiss. The only other sources in Peninsular India are the recent and sub-recent alluvial deposits which rest on the metamorphic and sub-metamorphic rocks. In extra-peninsular regions, gold is met with in rocks of different periods; in Ladakh in quartz reefs of carboniferous age; in Kandahár in cretaceous formations; while along the foot of the Himalaya the tertiary rocks which flank the base of the hills are more or less auriferous. Holland (*l.c.* 45) has pointed out that India occupies the sixth or seventh position among the leading gold-producing countries of the world, but that the total output is nevertheless insignificant, aggregating no more than 3½ per cent. of the world's annual supply. The following brief abstract of the available information regarding the occurrence and production of gold, province by province, may be useful:—

Production.

Origin
Geologically.

India's
Position.

Bengal.—Gold is obtained in Orissa, Midnapur, Bankura and in the Province of Chota Nagpur. In recent years attention has been drawn chiefly to the latter, where, under the control of the Geological Department, an extensive survey for gold has been conducted by several officers whose publications are mentioned below. The area examined covers part of the districts of Manbhum and Singhbum, with the tributary States of Gangpur, Bonai, Udepur and Jashpur. Commenting on Mr. Maclaren's final report, the Director says that though gold is

Bengal.
Chota Nagpur.

undoubtedly almost universal in the country examined, gold-prospecting could not (with one or two exceptions) be honestly recommended as a reasonable venture (*General Report*, 1902–3). The examination found the deposits in the quartz reefs to be very thin and patchy and the ore bodies small. "The recovery of gold from alluvial deposits," the report further adds, "offers no brighter prospects than that of mining quartz veins." [*Cf.* Noetling, *Sonapet Gold-Field*, in *Rec. Geol. Surv. Ind.*, 1890, xxiii., pt. ii, 73–8; 1896, xxix., pt. i., 2; King and Pope, *Gold, Copper, Lead in Chota Nagpur*, 1891; Hatch, *Rept. Parhardiah Quartzites*, in *Mem. Geol. Surv. Ind.*, 1901, xxxiii., 68–71; Holland, *Gen. Rept. Geol. Surv. Ind.*, 1901–2; 1902–3, 10–4; Maclaren, *Rec. Geol. Surv. Ind.*, 1904, xxxi., pt. ii., 59–91 (with map).]

Assam.

River-beds.

Point of Deposition.

Assam.—For an account of the gold of this province the reader should consult Maclaren's exhaustive paper on the *Auriferous Occurrences of Assam* (*l.c.* 1904, pt. iv., 205–32, with numerous plates and maps). In a brief notice on that paper, Holland (*Rev. Min. Prod.*, 1905, xxxii., 140) remarks that the most striking feature of the gold deposits of the Assam valley is the universal distribution of the metal in extremely small percentages throughout the gravel of the river-beds. This Maclaren holds to be due to two main causes, the wandering of the Brahmaputra over the plain and the wide distribution of the Tipam or Sub-Himalayan sandstones, which are certainly auriferous in places. The next characteristic feature is the general aggregation of gold at a point the distance of which from the hills is dependent on the strength of the current and the form of the gold dust. This point of general deposition is marked on the Assam rivers by the occurrence of gravels containing pebbles up to 6 inches in diameter. Above the point indicated the only deposition is that due to local diminutions in the velocity of the current, as on the beaches at the end of a long pool or on beaches lying parallel with the stream, and to which the gold is carried by the back eddies, where it is retained in the interstices between the large boulders.

Sadiya.

Dihong.

Subansiri.

The only gold deposits considered by Maclaren to be worthy of further prospecting are the Guri Mara, above the Sadiya and opposite the Chunpara Stockade; the Sibia Mukh on the Dihong river, and the Derpai pool on the Subansiri river. The most promising deposit is that on the Subansiri. The gold in general is of good quality, but the individual gold grains, except in a few places on the Subansiri, are extremely small and much flattened.

U. Prov.

United Provinces.—The production of gold in these provinces is comparatively unimportant. The only districts where it occurs in any quantity are Bijnor, Naini Tal and Garhwal, but the estimated production is only about 50 to 80 oz. per annum. The general method of working is the washing of auriferous sands found in the beds of certain rivers, most notably Ramganga, Sukhar Sot, Phika and Khoh in the Nagina Tahsil of the Bijnor district.

C. Prov.

Central Provinces.—Gold-bearing sands occur in most parts of these provinces, but the output is comparatively insignificant. The chief localities are Nagpur Division, especially Bhandara, Balaghat, Chanda, etc. [*Cf.* H. Nunn, *Monog. Gold and Silver-Ware*, 5–10.] In Central India gold appears to be confined to the Ajmere-Merwara district.

Panjáb.

Panjáb. The districts where gold is found are Bannu, Peshawar, Hazara, Rawalpindi, Jhelum, Kangra, Ambala, Gurgaon, and Hoshiarpur. The most important are the Jhelum district, where gold to the value of £770 was produced in 1901, and a fair amount in the Hazara district. It is said that recently an application has been made to the Panjáb Government on behalf of a Syndicate in British Columbia for the grant of a dredging lease for gold in the bed of the Indus. [*Cf.* Maclagan, *Monog. Gold and Silver Works, Pb.*, 1888–9; Robertson, *Settl. Rept. Rawalpindi*, 1893, 15; *Mem. Geol. Surv. Ind.*, 1897, xxvi., 287; *Madras Weekly Mail*, June 7, 1900, 502; *Capital*, Feb. 4, 1904.]

Kashmir.

Kashmir.—Gold-washing is carried on in some villages, chiefly in the Skardu Tahsil and Kargil Tahsil, Baltistan. In the former, the chief locality is the sands of the Bashahr river, and in the latter along the left bank of the Dras-Sooroo river from Hardas to Maimus, at Sher Alithang near Kharbu, and at Chuskor, some eight miles from Kargil. The market value of a *tola* is Rs. 20 and the State rate Rs. 18. [*Cf.* Drew, *Jummoo and Kashmir*, 1875, 409; Clarke, *Skardu Tahsil and Kargil Tahsil*, 1901, 10; Kaye, *Note on Assess. Rept. of Kargil Tahsil*, 1901, 45; Lawrence, *Valley of Kashmir*, 62.]

Bombay.

Bombay.—Auriferous rocks occur in the districts of Dharwar, Belgaum, Kaladgi, in the South Maráthá country, and in the province of Kathiawar, but the output of gold in late years has been very small. Recently, however, promising work in reef-mining has been commenced in the Dharwar district under the auspices of the Dharwar Reefs Company, Ltd.

Madras.

North Arcot Mines.

Madras.—Gold is found in Madura, Coimbatore, Salem, Wynaad, the Nilgiris, Travancore, Malabar, Kanara, North Arcot and Bellary. In recent years, however, all the gold produced in the Presidency was from the Kangundi mines in the Kangundi Zemindari of North Arcot. Work was commenced there in 1893 and was continued with varying success until 1900, since when working has ceased. The highest yield was obtained in 1898, viz. 2,854 oz. Prospecting has recently been carried on at Wynaad and three of the old mines were open during part of 1901, but did not yield any gold. [*Cf.* Hayden and Hatch, *Gold-Fields of the Wainád, Mem. Geol. Surv. Ind.*, xxxiii., pt. ii.]

Mysore.

Mines of Kolar Field.

Champion Lode.

19 Million Pounds.

3,000 Feet deep.

Electric Power.

New Discovery.

Mysore and Hyderabad.—The gold of Mysore State is solely derived from the Kolar district, which occupies a small tract of country in the eastern extremity of the State. Roughly, the field is about ten miles long from north to south, two miles wide from east to west, and made up of synclinal folds of schistose rocks. Hatch says that the auriferous lodes of the Kolar gold-fields consist of a series of parallel quartz veins which occupy a central position in the belt of Dharwar schists. Although there are several parallel veins, it is on the Champion lode only that paying mines have been developed. "The attention of European prospectors was directed to this area by numerous Native workings of unknown age; and since operations commenced on a large scale, shortly after 1880, the gold extracted, up to the end of 1903, has reached a value of nearly 19 millions sterling. During this period five companies have paid £8,250,000 in dividends, while the Mysore State has received nearly one million as its royalty. The deepest workings, now somewhat more than 3,000 feet below the surface, show little diminution in the value or width of the auriferous quartz vein. During the past five years the amount of quartz crushed has increased from 337,636 tons in 1898 to 546,752 tons in 1903, and the value of gold extracted has increased from £1,576,000 in 1898 to £2,284,000 in 1903." [*Imp. Gaz.*, 1907, iii., 14.] Holland observes that various improvement schemes, with the object of reducing working expenses, have been introduced in recent years, one of the most important being the provision of electric power from the Kauveri Falls. The supply commenced about the middle of 1902, and has regularly furnished over 4,000 horse power to the various mining and metallurgical works. In *The Madras Weekly Mail* (June 1, 1905, 597) an account is given of a new discovery of gold in Mysore at Yellahanka, 22 miles north-east of Bangalore, which seems of future importance.

Mines.

The citation of publications in the opening paragraph practically denotes those of Madras and Mysore, but there may be added the annual reports of the various companies, of which, in alphabetical sequence, the following may be quoted:—1. Balaghat Gold Mining Company; 2. Champion Reef Gold Mining Company; 3. Coromandel Gold Mining Company; 4. Ooregum Gold Mining Company; 5. Mysore Reefs Company; 6. Mysore Gold Mining Company; 7. The New Kempinkote Gold Field; 8. Nine Reefs Company; 9. The Nundydroog Company; 10. The Oriental Gold Mining Company; 11. the Road Block Gold Mining Company, etc.

Hyderabad

In Hyderabad the only quartz mines producing gold are those of Hutti and Wundalli in the Nizam's Dominions. At the Wundalli mine 7,822 oz. of gold were recovered in 1899, but the mines were closed in 1900, and the Hutti mine was the only one at work at the end of 1903. In the latter mine the total output for 1903 was 3,414 oz.

Burma.

Irrawaddy.

Burma.—The only reef mine of importance is the Kyankpazat near Wuntho in Upper Burma. Holland tells us that this mine yielded in 1898, 1,120 oz., and maintained and indeed increased its yield until 1902, when 1,984 oz., valued at £7,606, were produced, but in 1903 the auriferous chute was worked out and the mine closed. From recent exploration, however, Burma appears to be very rich in alluvial gold, and in 1903 a license was issued to a Company to dredge gold in the Irrawaddy above Bhamo. Gold to the value of Rs. 2,016 was produced, and the result was sufficiently successful to induce the Company to extend its operations. The greater possibilities of dredging on the Irrawaddy appear to arise from the fact that the waters of the river are derived from ranges where, even in the cold weather, there is a heavy rainfall. [*Cf. Imp. Gaz.*, 1907, iii., 141–3.] *The Indian Agriculturist* (Feb. 1905) gives the practical results of an interview with Lt.-Col. Mackenzie Foss, on the subject of the occurrence of tin and gold in Lower Burma, in which that gentleman apparently stated that, in his opinion, the district of Mergui was one

Mergui.

of the richest in alluvial gold in the world. [*Cf.* Nisbet, *Burma under Brit. Rule and Before*, 1901, i., 347, 397 ; *Rec. Geol. Surv. Ind.*, 1892, xxv., 129 ; 1893, xxvi., 7, 48, 163 ; 1894, xxvii., pt. i., 10–11, 117, 122–3.]

Uses.

Uses.—Gold is largely employed by the richer classes in India for the purpose of personal adornment or in the ornamentation of sacred buildings, palaces, etc. The most important art industries for which it is employed are, therefore, coins, jewellery, gold-leaf, gold wire and thread (used in the fabrication of cloth of gold (*kinkhabs*), braids, lace, etc. Stein (*Ancient Khotan*, 1907, 192–4, 210, 224, 381, 496) discusses the gold-digging at Yotkan and mentions the instances where he found gold employed by the artists of the sand-engulfed ruins. These date from the 3rd to the 8th centuries. While he found gold-leaf extensively employed in the ornamentation of the idols, statuary, etc., he makes no mention of having come across an example of fabric with gold wire (thread). He met with Chinese and Tibetan brocaded silks, but no examples of the Indian *kinkhab*.

Medicine.

For the uses of gold in MEDICINE, the reader should consult Dutt (*Mat. Med, Hind.*, 1900, 57–61). [*Cf. Ain-i-Akbari* (Jarrett, transl.), iii., 315–6 ; Mukharji *Art Manuf. Ind.*, 1888, 97–144 ; *Ind. Art at Delhi*, 1903 :—Gold and Silver Plate, 31–42, Gold Brocades (*kinkhabs*, etc.), 319–38, Gold-wire, 416–8, Gold and Silver Embroidery, 419–24, Jewellery, 489–93. The following enumeration, province by province, of the publications that deal with the Indian industries that employ gold may be found useful :—BENGAL : Mukerji, *Monog. Gold and Silver Work*, 1905. ASSAM : Henniker, *Monog.*, 1905. UNITED PROVINCES : Hoey, *Monog. Trade and Manuf.*, 110-3, 157, 184, 194, 196–7 ; Charles, *Monog.*, 1905. PANJÁB : Maclagan, *Monog.*, 1890. CENTRAL PROVINCES : Nunn, *Monog.*, 1904. BOMBAY : Burns, *Monog.*, 1904. MADRAS : Havell, *Rept. Arts and Manuf.*, *Govt. Proc.*, 1886, 5, 6, 13, 15. BURMA : Max and Bertha Ferrars, *Burma*, 1900, 107–11.]

Trade.

TRADE.—If Max Müller and others be correct in identifying India with the Ophir of Scripture, the present production is possibly only a tithe of what it has been. According to Napier (*Metallurgy of the Bible*), King David derived, through the trade of Ophir, gold to a valuation of £600,000,000. But another opinion fixes Ophir in West Arabia. Pliny speaks of Indian gold coming from the country of the Nareæ (the Nairs of Malabar), and thus practically the Mysore mines.

Imports.
Declining.

" Within the past few years the net imports of gold have apparently diminished. Thus the excess of imports over exports during the ten years ending 1891–2 averaged about 729,900 oz., while during the following ten years the average did not exceed 442,400. The reduction is mainly due to two causes. Large imports of gold had been made by banks to be exchanged for silver, and the accumulation of gold coin having been found inconvenient by Government—for gold does not circulate freely in the country the surplus was shipped by the Government to London, where at the same time considerable purchases of silver were made for additions to the coinage. Secondly, the Mysore gold-mines now send to London large quantities of gold every year, and this export reduces the net imports shown in the trade returns. It is probable that on the whole there was no real decline in the demand for gold in India, which is in value about half of that of silver. In 1902–3 the net imports rose to 1,417,000 oz., and in the following years to 1,566,237 and 1,516,991 " (*Imp. Gaz.* 1907, iii., 292).

Indian Productions.

Holland (*Rev. Min. Prod.*, *l.c.* 47), commenting on Indian production, observes, " For the six years under review the value of gold extracted was £11,310,038 or 60 per cent. of the total value (£18,687,818) extracted in the twenty-one years since the commencement of work under European supervision. With the increase in output dividends have also increased, rising from £739,114 in 1898 to £1,019,347 in 1903, or an increase of 38 per cent.

Dividends.

The total dividends paid during the six years were £4,988,793 or 60 per cent. of the dividends (£8,287,071) paid since 1882, indicating that dividends and output have advanced *pari passu*." [*Cf.* O'Conor, *Rev. Trade Ind.*, 1902–3, 28–9, 37–8; *Rept. Beng. Chamber Comm.*, 1903, 145–51; *Imp. Gaz.*, 1907, iii., 291–2.]

D.E.P., iv., 1–174. Cotton.

GOSSYPIUM (Cotton); Watt, *Wild and Cult. Cotton Plants of the World*, 1907, 1-406, tt. 1–53. A genus of MALVACEÆ, the species of which are widely distributed on both sides of the equator, and in both hemispheres. On the north they extend, under cultivation, to Crimea (45°), and on the south to the latitude of the Cape of Good Hope (34°).

Scientific Names.
Wild Species.
Perennials.
Character of Seed.
Velvet or Fuzz.
Naked.
Kidneyed Seeds.
Protective Measures.
Colour of Floss.

Few cultivated plants are so difficult to understand or have been half so much confused through conflicting opinions regarding the existing forms as the cottons. Practically all the botanical names in current use were founded on cultivated plants, and these changed subsequently, and in some cases so rapidly that they are now mostly unrecognisable. Instead of rejecting a nomenclature thus hopelessly useless, one botanist after another has given his peculiar views and reassorted the published names. The obvious duty of establishing species on the wild forms and grouping the cultivated states as near as may be possible under these, has been absolutely neglected and the literature of the genus become confusion worse confounded. Useless controversies have engaged attention, such as whether there are fifty or more species, or only three, or even only one in the whole world; another, whether a single characteristic of supreme value can be discovered, upon which a classification of the forms might be based. The early authors divided the cottons into trees and bushes, or into perennials and annuals. It has now been established beyond dispute that all species of *Gossypium* under suitable environment are perennials if left alone, and may in time become large bushes or even small trees. Moreover, when cultivated they readily respond to environment, and when necessity exists become annuals or otherwise adapt themselves. On dry stony soils they are usually perennials, on rich loamy soils annuals, more especially if restrained by cold in the winter months or by a heavy periodic (monsoonic) rainfall or by infestations of pests. Some writers have placed confidence on the characteristics of the seed as affording a key to classification. If possessed of a double layer of wool, viz. an under-velvet or fuzz (as it has been called) and an outer layer or floss (the true wool or lint), such seeds have been regarded as denoting very different plants from those with a naked seed, that is to say, not possessed of the under-coating (fuzz). This conception originated the classification into *album* (white or fuzzy seeds) and *nigrum* (black or naked seeds). So again the fact of the seeds being free from each other or attached together into what has been called a "chain" or "kidney" mass, has been accepted as a further means of diagnosis. But as opposed to such views it has recently been shown that certain structural peculiarities have originated in consequence of adaptation to beneficial insects, such as the *kelep* ant of Guatemala, or as protective measures against enemies. Of this latter kind may very probably be the formation of the floss and of its special and varied peculiarities. Hence another set of writers have rejected all the distinctions based on the fruit or seed and have advanced the argument that selection should primarily be directed towards lowering the size and weight of the seed, and thus increasing the proportion of wool. No structural manifestations would accordingly be less constant than those based on the seed and floss. But the colour of the fuzz and floss have been even more frequently utilised as aids in classification than structural characters. The names *Nanking*

Kakhi Cotton. and *religiosum* were at first used to denote a red or *kakhi* coloured floss, and the belief was accepted that all wools of that colour were obtained from one and the same species. As opposed to that view it may be mentioned that Fortune (*Three Years' Wanderings in China*, 1847, 264) says that the *mie wha* or yellow cotton of China cannot be separated from the white form, and that the seed may come up either white or yellow. [*Cf.* Liotard, *Note, Nanking Cotton in India*, 1883.] As a matter of fact it would now appear certain that most wild cottons have a red-coloured fuzz or even a red fuzz and floss: accordingly, under negligent cultivation or as acclimatised escapes from cultivation, the woolly coating of the seeds, in the majority of species, may become reddish coloured. Conversely, red-coloured cottons, if carefully cultivated, invariably lose their colour and become white. Lastly, still other writers have sought for a classification based on the shape and degree of hairiness of the leaves and bracteoles or the shape and colour of the flowers. But, as with most other cultivated plants, the classification of the forms of ***Gossypium*** is alone possible on the basis of the wild plants and through an aggregation of all natural characteristics, including geographic and climatological considerations, and not upon any arbitrary (single) standard.

Hairiness of Leaves.

In this view it may now be desirable to furnish the practical results of a special study of the genus ***Gossypium*** (restricting attention as far as may be possible to the Indian forms) and to draw up the history of the available information regarding the cotton industry, with special reference to the periods of discovery, the stages in cultivation, the improvement of the plants of commerce, and the progression in industrial knowledge :—

History.

I. THE HISTORY OF THE COTTON PLANT AND COTTON INDUSTRIES.

It would not be far from correct to describe cotton as the central feature of the world's modern commerce. Certainly no more remarkable example of a sudden development exists in the history of economic products than is the case with cotton. The enormous importance of the textile to-day, in the agricultural, commercial, industrial and social life of the world, renders it difficult to believe that but little more than two hundred years ago cotton was practically unknown to the civilised nations of the West. But it is perhaps even still more singular that a fibre which, for many centuries apparently, had been a staple article of clothing in India and the East generally, should scarcely find a place in the early classical literature of these countries. Nearly all the beautiful and useful plants of India have their properties extolled by the Sanskrit poets, and indeed are frequently dedicated to the gods, but cotton—the plant above all others which might have been expected to have formed the theme of nature-worship—is hardly more than incidentally mentioned.

Indian Knowledge. The Sanskrit word *kárpásá-í*, often rendered cotton, is connected with the Greek and Latin *carpasos* or *carbasus*, and denoted a fine textile. That name was also known to the Phœnicians and Hebrews, but whether it originated in India or was imported there would be hard to say. Mr. F. W. Thomas, who has kindly permitted me to consult him on this point, informs me that "the earliest mention appears to be in the *Ásvaláyána Śrauta Sútra* (say 800 B.C.), where the material is contrasted with silk and hemp, as that of which was made the sacred thread of the Brahmans. Probably the word was thus borrowed from India. The other words *túla* and *picu* are later—they denote the substance. The Sanskrit dictionaries give four names (*vadara, kárpásí, tuṇḍikeri* and *samudrántá*) for the shrub, while the wild kind is called *bharadvájí*. They also mention that *kárpása* and *vadara* (the material) come from the fruit of the plant in question, while the *Harṣacarita* (*circa* 650 A.D.) twice speaks of the cotton (*túla*) from the pods of the *śálmali* tree" (= *semul*, ***Bombax malabaricum***). In the *Institutes of Manu* injunctions exist that regulate the operations of the washermen and of the weavers, and these all point to a social organisation and industrial attainment in which a knowledge of cotton is essential, but it is taken for granted rather than expounded or justified. All this might of course argue antiquity, as it certainly does for the arts of spinning and weaving, but the word *kárpásí* may have existed for centuries with a generic rather than a specific signification.

Classic Names.

Greek Discoveries.

Similarly it is extremely difficult, if not impossible, to determine the earliest certain references to cotton in the Persian, Arabic and European classics. It is fairly clear that *kutn, katán* or *kutun* (the Arabic name from which we have derived the English word cotton) originally denoted flax, not cotton. So also in Greek, *karpasos*, often rendered cotton, had, as already stated, the still earlier meaning of flax or simply of a fine textile. But cotton textiles had been carried to Europe, and were regularly traded in, long before any definite knowledge existed there regarding the fibre of which they were made. In fact the Greeks first learned definitely of the cotton plant through the group of explorers who visited India along with Alexander the Great and his immediate successors in Bactriana. Herodotus (450 B.C.) had written of India having *wild trees* that bear fleeces as their fruits. But right down to the middle of the 18th century the wool-bearing trees were divided into those with spinose and those with smooth stems. The former were the silk-cotton trees, of which ***Bombax malabaricum*** may be given as the type, while under the latter many of the botanical writers included *kapok* (***Eriodendron anfractuosum***).

Quilting-cottons.

First Description.

A large percentage of the earliest authors speak of cotton being used for quilts and mattresses, but are silent regarding its being spun and woven. Ktesias would appear to have been the first European who observed the spinning and weaving of the Natives of India, but his description does not necessarily denote cotton as the fibre. Theophrastus (350 B.C.) gives us the first definite conception of Indian cotton cultivation. He says (*Hist. Pl.* (ed. Schneider), iv., ch. 4, 132), "The trees, from which the Indians make cloths, have a leaf like that of the mulberry; but the whole plant resembles the dog-rose. They set them in the plains arranged in rows, so as to look like vines at a distance." He then adds that cotton cultivation may be seen both in India and Arabia. Indian cotton-bearing plants set in rows necessarily involves cultivation, but it would be equally applicable to the perennial as to the annual plant. The comparison to the dog-rose, with its open lax branches, however, brings to mind the perennial *roji* of Gujarat rather than the small compact bush of the ordinary annual cotton. (See below, under **Roji**, p. 581.)

The First Definite Account of Indian Cotton Trade.

Oldest Actual Samples.

Pliny tells us that cotton (*carbasa*) was in Tylos called *Gossympines.* He does not state whence he derived that information, but curiously enough by modern botanical writers that word has become the generic name for the cottons (***Gossypium***). In the *Periplus of the Erythræan Sea* (63 A.D.) we have the first commercial mention of Indian cottons. The raw cotton, as also the Indian cotton manufactures, were conveyed by the Arabs from "Patiala, Ariako and Barygaza" (the modern Broach) up the Red Sea to "Aduli." The *Indika* of Arrian, a work compiled (150 A.D.) from Nearchus, Megasthenes, Strabo and Eratosthenes, as also other early Greek travellers, was professedly intended to supersede the inaccurate account of India given by Ktesias. After narrating the particulars above mentioned, Arrian adds that the cotton of India is whiter and brighter than that of any other country. Thus by the beginning of the Christian era we have a fairly vivid glimpse of India as a cotton-growing and cotton-manufacturing country. Stein (*Ancient Khotan*, 1907, 374, 412, 430, 442, etc.) mentions that cotton cultivation is very largely pursued around the modern Khotan, and in other passages he refers to fragments of cotton garments, etc., found in the ruins of the ancient city, which must be accepted as dating from the 3rd to the 8th century. These are doubtless the oldest authenticated examples of the Central Asiatic cotton industry at present known.

The simple reference to a fibre or textile, under such names as *kárpási, katán, linon, carbasus* or *Gossypion* may be of no historic value whatever. It has to be shown that the word used had the same signification then as to-day. Many illustrations might, in fact, be given of the confusion that prevailed regarding the separate recognition of the chief textiles of the world, down even to the 17th century. In Manchester, for example, a particular texture of goods, woven of wool, was in 1590 sold under the name of "Manchester Cottons." In 1664 the dispute between Sir Martin Noel and the East India Company as to whether "Calico was linen or no" became acute, and that controversy shows how very reluctantly the name "cotton" was in England accepted as indicative of a distinct fibre.

Arab Authors.

Perennial Cottons.

Drawn through a Ring.

Cotton in China.

There is, however, every reason for believing that the Arabs knew of cotton and wore cotton garments before the present era. Unhappily no writer can be discovered who effectually bridges over the gap between the period of the *Periplus* and that of the physicians who wrote in the 7th to the 10th centuries. Serapion, an Arab medical writer (who lived about 850 A.D.), quotes several earlier Arab authors, among whom Ibn Hanifa, he says (speaking of Kelbe), described the cotton as growing there on trees which lived for twenty years but attained their best bearing condition about the ninth year. Renaudot gives a translation of the journal of an Arab (Sulaiman) who visited China and India in the 9th century. The original Arabic MS. bears the date 1173, and was translated in 1718 by Renaudot, and again in 1845 by Reinaud into French; but there is an English edition dated 1733. Speaking of the town of Calicut, he says that "garments are made in so extraordinary a manner that nowhere else are the like to be seen. They are for the most part round and woven to that degree of fineness that they may be drawn through a ring of middling size." Sulaiman also makes special mention of the fact that the Chinese, rich and poor, were seen to be dressed in silk, but he says nothing of cotton in China. It is one of the many surprises met with everywhere in the study of the world's production and trade in cotton, that the plant was not cultivated in China for its fibre until the 13th century. In the 6th century we read of the Emperor Ou-ti having possessed a robe of cotton that he held in much esteem. Towards the end of the 7th century cotton was an ornamental shrub in Chinese gardens. Mayer says that it was not until about 1000 A.D. that the plant was fully introduced into China, and this view is accepted by Bretschneider. There was apparently in China (as in Europe) much opposition to the introduction of cotton as a textile.

Indian Perennial Cottons.

Marco Polo (who travelled through a large portion of Asia in 1290 A.D.) refers to the production and manufacture of cotton in Persia, Kashgar, Yarkand, Khotan, Gujarat, Cambay, Telingana, Malabar, Bengal, etc., but is absolutely silent on these subjects in connection with China. Speaking of Gujarat, he says the cotton trees are of great size and attain an age of twenty years, but he adds, when of that age the cotton is only used to quilt or stuff beds. Referring doubtless to Masulipatam, he says it produces specially fine "buckrams" (muslins) and chintzes. The Rev. E. Terry, Chaplain to Sir Thomas Roe's Embassy to India in 1615, speaks of the cotton plants near Surat as growing for three or four years before being uprooted. The cotton plant seen by Rheede in Malabar, during 1686, he describes as a shrub 10 to 12 feet in height, found growing in sandy places—he does not say cultivated.

Cotton in Egypt.

First cultivated there.

Arabian Knowledge

Turning now and very briefly to Egypt. Pliny, in his account of Æthiopia, speaks of the portion that borders on Egypt having cotton plants that afford a more woolly fibre than is customary and as possessing exceptionally large pods. Yates (*Text. Antiq.*, 1843, 334–54), commenting on that passage, observes that the plant referred to may have been ***G. arboreum***. He further says that cotton was not grown in Egypt proper during ancient times. In support of that view he affirms that the MS. copies of both Pliny and Julius Pollux (a century later than Pliny), that have been cited as upholding an ancient cultivation, have had that interpretation put upon them through marginal annotations which were made about the 14th century A.D. being taken as parts of the original text. He accordingly maintains that cotton was first cultivated in Egypt about the 13th or 14th centuries, and in support of that opinion mentions the fact that the Arab physician Abdullatiph, who visited Egypt in 1200 A.D., and published a list of the plants he saw, makes no mention of cotton. Further, Yates points out that the ancient paintings and sculptures of Egypt, while they show flax cultivation and purification of the fibre, give not the slightest indication of cotton. And this view is confirmed by Prosper Alpinus (*De Pl. Ægypti*, 1592, 29), who makes the significant observation that the Egyptians in 1592 imported cotton for their own use from Syria and Cyprus, and only cultivated in their gardens, as a curious and ornamental plant, the ***Gossypium*** which he figured and described, viz. ***G. arboreum***. He adds, however, that the Arabs make webs of that cotton which they call *sessa*. Forskal (*Fl. Æg. Arab.*, 1775, 125) indicates two forms of cotton met with by him: *G. rubrum*, which he says was known to the Arabs as *oth, hadiæ*, or *odjas* (from the description given, the plant indicated was very likely to have been ***G. arboreum***. *Linn*); while his second species (which he calls *G. arboreum*) answers fairly closely to ***G. herbaceum***. [*Cf.* Adler and Casanowiez, *Biblical Antiq.*, in *Ann. Rept. Smithsonian Inst.*, 1896, 1005.]

Perennial Cottons.

It is thus very remarkable that the accounts given by the earlier authors regarding Indian and Egyptian cottons almost all point to perennial, not annual plants, and so persistently as to suggest that the annual stock may have been a subsequent discovery obtained very possibly from Arabia.

Earliest Indication of Annual Cotton.

In the 9th century Sicily was taken by the Saracens, and according to Abu Zacaria Ebn el Awam (Banqueri, transl., ii., ch. 22, 103) they at once introduced the cultivation of cotton. From the account given of the methods of cultivation the plant must have been the annual stock, now known as ***G. herbaceum***. In the 10th century the Muhammadans carried the self-same cotton plant (as I take it) across the Mediterranean to Spain, and for three centuries thereafter Barcelona had a flourishing cotton industry. There would thus seem no doubt the plant disseminated by the Muhammadans was ***G. herbaceum***, the species presently cultivated in the regions indicated. Where they obtained that plant may be a matter of uncertainty, but to-day the centre of its area of cultivation might almost be given as the northern tracts of Arabia and Mesopotamia, where it stands every chance of being indigenous. There is no doubt, however, that the Levantine (not the Indian) plant was closely associated with the early Saracens; their religion, their cotton and their sugar might be spoken of as the triple agents of their civilisation. As a cultivated plant, that cotton was carried by them to Constantinople, and very possibly through Turkey, Asia Minor, Armenia, Kurdistan and Mesopotamia to Persia, if not even to the frontier of India. So also they in time may have conveyed it to Egypt, in connection with their Baghdad trade, which on the conquest of Spain went *viâ* Alexandria. But before passing away from this subject it may be added that there would seem no doubt a limited cultivation of cotton had been established in Crimea and South Italy some short time prior to the European conquests of the Saracens, so that it is just possible it may have existed, if it was not indigenous in some of the islands of the Mediterranean, prior to the knowledge of its utilisation as a textile, just as the tea plant existed in Assam prior to its being brought from China by Gordon and Fortune. It is not surprising, therefore, that Dioscorides should make no mention of cotton. The cultivation of ***G. herbaceum*** in time, however, was diffused throughout the countries bordering both shores of the Mediterranean, and a cotton trade was established which held sway for several centuries.

Dissemination of *G. herbaceum*.

Its Early Cultivation in Europe.

England's Position.

It may perhaps suffice for the purpose of this work to indicate very briefly the chief historic facts in the rise and present position of the cotton production and trade of the New World and of the cotton manufacturing enterprise of Great Britain. The earliest mention of the English cotton trade appears to occur in a little poetic work entitled *The Politie of Keeping the Sea.* This is given by Hakluyt in his *Voyages, etc.* (i., 213), and was apparently originally published in 1430. The merchants of Genoa are spoken of as carrying silk, pepper, woad and cotton to England, and as taking back woollen goods. It is thus probable that at an even earlier date than indicated England procured cotton from the Levant, since the fibre is spoken of as an ordinary commodity. In 1492 Columbus discovered the West Indies and America. The Spaniards on their arrival in the New World found cotton being cultivated and manufactured, from the West Indies to Peru and from Mexico to Brazil. In 1498 Vasco da Gama sailed for India round the Cape of Good Hope. The success of that expedition gave to Western Europe a direct route to India, and struck a severe blow at the commercial supremacy of Venice and Genoa. "Thus previous to the discovery of America and the West Indies and for some time afterwards, England, and probably all Europe, were supplied with cotton from the Levant" (Milburn, *Or. Comm.*, 1813, ii., 279–82). Down to the close of the 16th century England obtained her cotton (a small demand) from the Levant, and her supplies of Indian cotton goods *viâ* the Mediterranean ports. As late as 1641 we read that "the town of Manchester buys cotton-wool in London, that comes first from Cyprus and Smyrna." The supply, if any, from the West Indies must accordingly have been very insignificant. The early historians of Brazil affirm that a cotton plant was found indigenous there, and that the Natives made use of it to supply the cotton of their simple needs. In Bahia it must have been cultivated, however, since De Souza speaks of it (1570–87) as cleaned with the hoe, two or three times a year. Pizarro in 1522 found cotton in Peru, and it has since been recognised in the ancient tombs of that country. De Vica is reported to have discovered, in 1536, a wild cotton in Texas and Louisiana. Thus then, when first made known to Europe, the American continent, as also the West Indies, possessed not only a cotton industry but both wild and cultivated cottons, independent of those of the Old World. But we know nothing for certain of

Discovery of America.

Direct Route to India.

English Supply.

Brazil.

Peru.

United States.

the species of American cottons until approximately two centuries after their original discovery.

United States Cultivation.

Levant Seed.

The first attempt to grow cotton in the United States was in Virginia. It was not, however, until the second decade of the 17th century that systematic cultivation was organised, and then from seed obtained both from the Levant and from the West Indies. It took nearly a hundred years from that date before the plantations became of national importance, but the seat of the industry gradually shifted south and west. England began to manufacture cotton about 1635, and continued to draw on the Levant for her supplies of the raw fibre. An outcry against the imports of Indian cotton goods began to be raised in England. Marcgraf (who died in 1644) speaks of the cotton seen by him in Brazil as having the seeds united together—the condition we now call kidney-cotton. According to Samuel Wilson, Smyrna and Cyprus seed, by the close of the 17th century, had been successfully acclimatised in Carolina.

Repressive Legislation.

Original Green Seed.

Brazilian Cotton in English Markets before States Cotton.

Sea Island Cotton sent to the States.

The 18th century opened with repressive legislation passed by the British Parliament against Indian calicoes, but witnessed the imports by England and Scotland of raw cotton amounting to 1,000,000 lb. Cotton was raised in Georgia from seed supplied from Chelsea by Philip Miller (the original stock of the green-seeded plant now known as ***G. hirsutum***). In 1782 muslins were first made in England, and in that year South American or Brazilian cotton began to be regularly received. Two years later a ship which brought eight bags of cotton from America to Liverpool was seized on the ground that so much cotton could not have been produced in the United States. In 1786 the green-seeded cotton was in the States the most largely grown of all kinds, but in that year the black-seeded or Sea Island cotton was introduced from the Bahamas.

Efforts made to improve Indian Cotton.

English Supply and Market.

Through Patrick Walsh, Pernambuco cotton was successfully introduced into the United States in 1789. Dr. Hove was sent to India to study the Indian cotton trade and Indian cotton plants, but his mission was resented by the East India Company, and his report was not published for sixty years after his return to England. Shortly after the date of Hove's visit the East India Company commenced, however, a series of experiments with a view to improve the quality and increase the quantity of cotton produced in India. Up to this point England obtained her supplies of raw cotton from the Levant, India, the West Indies and South America, the finest qualities being spoken of as coming from Surinam and Cayenne. The century closed with the exports from the United States to England at 9,532,263 lb. and from India at 729,643 lb.

Cotton Crop of U.S.A.

First Indian Cotton Mill.

States Cottons crossed with Mexican.

The 19th century opened with the cotton crop of the United States being returned as 48,000,000 lb., contributed as follows :—South Carolina, 20 million ; Georgia, 10 million ; Virginia, 5 million ; North Carolina, 4 million ; and Tennessee, 7 million pounds. The exports from that crop to Great Britain were 20,000,000 lb. Total consumption of raw cotton in Great Britain came to 54 million pounds, the supply from India being 6½ million pounds, or just one-third of the quantity drawn from the new area—the United States of America. The first Indian cotton mill was built near Calcutta in 1818, and the first of the Bombay series in 1851. Improvements in bleaching, dyeing and cylinder printing soon placed British calicoes in a position to hold their own against similar goods from any other part of the world. Resist printing was introduced by Sir Robert Peel. The Sea Island cotton raised at Hilton Head, South Carolina, fetched the highest price then known. Mexican cotton-seed was introduced into Mississippi by Walter Burling, and by crossing with the existing plant was supposed to have improved the quality of the cotton very greatly. Mention, so far as I can discover, has never been made of any of the indigenous cottons of the States (if such existed) having been grown by the colonists. They grew first Levant cotton, then Miller's green-seeded cotton, and finally Sea Island cotton. Which of these was crossed with Mexican has not been stated, but presumably the green-seed, and this hint should be of value.

Egypt.

Efforts of the E.I.C.

Cotton cultivation was systematically prosecuted in Egypt about 1821, and rapidly obtained a position in quality of staple second only to that of the States, but there is very little information as to the original stock or of the subsequent stages in the production of the better races now met with in that country. The year 1825 witnessed ruinous speculation in cotton. From 1829 to 1841 the East India Company made strenuous efforts to improve the Indian staple. Large sums were spent in the form of awards, and ten experienced cotton-growers were procured from the Southern States of America with a view to establish the cultivation of New Orleans cotton. Excepting in Dharwar, failure was the only result, and the subject was allowed to drop from public attention. In 1841 cotton yarns were in Manchester spun up to No. 450's, and the United States rapidly obtained a monopoly of the market in raw cotton. In 1850 the imports into Great Britain were 664 million pounds of raw cotton, and her exports of manufactured cotton goods were valued at £28,000,000. About this time a scheme was formulated in England to raise a sum of £20,000,000 to be expended in India during five years, in measures calculated to forward India as a cotton-producing country. The outbreak of the Mutiny put an end, however, to these negotiations. Commenting on the effect of the American Civil War and the Great Cotton Famine of 1862–6, Dabney (*The Cotton Plant, U.S. Dept. Agri. Bull.*, 1896, No. 33, 14) very truly observes, "Probably no equally great industry was ever more completely paralysed or had its future placed in greater jeopardy than cotton-growing in the United States during the war of 1861–5." In 1863 a Cotton Commissioner was appointed for Bombay, and the year following for Berar and the Central Provinces. Cotton farms were established under these Commissioners. The Bombay Cotton Frauds Act IX. of 1863 became law, but it is generally believed it did more harm than good and was shortly after repealed. For the ten years ending 1859 Great Britain imported an average of 2,318,575 bales of cotton (each 400 lb.), and of that amount India supplied 405,291 bales. But the ten years ending 1869, which included the troublous times of the American war, Great Britain imported an average of 2,736,661 bales, of which India supplied 1,282,172 bales—the record year being 1866, when India furnished 1,847,759 bales. Thirty years later (1899) Great Britain took 4,065,617 bales, of which India furnished only 77,297 bales; but in 1903 the Indian portion slightly improved, Great Britain having taken 203,550 bales of Indian cotton.

India's Cotton Commissioner.

India's Capabilities.

The immediate response made by India during the cotton famine shows her capabilities, but as in the United States, so in India, the demands of her own mills had become a controlling factor in the amount available for export. But the 19th century closed with India, instead of exporting cotton goods, having become the largest single market for English manufactured cottons—its demands for British cotton goods having been just under £20,000,000.

A New Phase.

The 20th century may be spoken of as characterised by a new feature, namely, the rise of Continental, American and Indian cotton-manufacturing enterprise seriously threatening the supremacy of England in the cotton markets of the world. The Tariff Commission's Report of June 6, 1905, may be said to have been written with a view to establish this new phase. From that publication the following may be abstracted:—In 1876–80 the annual consumption of cotton in the United Kingdom exceeded that of the Continent by 2,030,000 cwt., and that of the United States by 5,070,000 cwt.; in the period 1901–4 the annual consumption in the United Kingdom was 8,020,000 cwt. less than on the Continent, and 2,950,000 cwt. less than in the United States.

For further particulars of historic interest the reader should consult the chapter below on Indian Trade in Cotton. [*Cf.* Donnell, *Hist. Cotton*, 1872; De Candolle, *Orig. Cult. Plants* (Engl. transl.), 402–11; Branner, *Cotton in the Empire of Brazil*, in *U.S. Dept. Agri. Misc. Bull.*, 1885, No. 8; Nasmith, *Inaugural Address*, delivered 1896 (reprinted), *Ind. Text. Journ.*; Handy, *Hist. and Gen. Stat.*, in Dabney, *Cotton Plant*, 1896, 17–66; also *Bibliography of Cotton*, *l.c.* 423–33; Eckardt, *Der Tropenpflanzer* (suppl.), Feb. 1906, vii.]

II. THE CULTIVATED AND WILD COTTONS OF INDIA.

(A) FUZZY-SEEDED COTTONS OF THE OLD WORLD.

D.E.P., iv., 16. Sind and Arabia.

G. Stocksii, *Mast.*, *Fl. Br. Ind.*, 1874, i., 346; Watt, *Wild and Cult. Cotton Pl. of the World*, 1907, 73–7, t. 6; *hiraguni kápas.* This very interesting wild species is found near Karachi, India, and across the Persian Gulf, on the Dhofar Mountains of South-East Arabia.

There would seem little doubt that the writers who have supposed this to be the wild condition of **G. herbaceum**, *Linn.*, are in error, but not more so than those who have taken it for a naturalised and degenerate state of some American species. Moreover, no one would appear to have demonstrated by actual experiment the forms, if any, that have resulted from using **G. Stocksii** in hybridisation with other species, hence its influence on the Indian cultivated cottons must be accepted, for the present, as purely imaginary.

D.E.P. iv., 25–30. Levant Cotton.

G. herbaceum, *Linn.*, *Sp. Pl.*, 1753, ii., 693 (in part); Parlatore, *Sp. dei Cot.*, 1866, 31–6, t. ii. (in part); Todaro, *Relaz. Cult. dei Cot.*, 131-40, t. iv., ff. A-C; Aliotta, *Riv. Crit. Gen. Goss*, 1903, 66-75 (in part); Watt, *l.c.* 155-63, tt. 24-5. Syrian, Levant, Arabian and some of the Short-staple North American Cottons.

Habitat.—Probably indigenous to North Arabia and Asia Minor. Not known to exist as a wild species anywhere. It occurs in the Mediterranean regions (Sicily, Malta, Greece, Crete, Cyprus, Algiers, Turkey), in Syria, Mesopotamia, Armenia, Persia, Afghanistan, Baluchistan, in the North-West Frontier Province of India, and in the northern portions of the cotton area of the United States of America. It may, in fact, be described as a warm-temperate species, and is at least one of the plants that yields, or formerly yielded, the so-called "Short-staple American Cotton" of commerce. There is every reason for believing that it was the species first cultivated by Europeans. It was the bushy, cultivated, annual *Gossypium* or *Xylon* first mentioned by botanical writers. Moreover (as already fully shown), the field plant of the Levant was the first commercial cotton of Europe, which, at an early date, was carried to the United States and there largely cultivated some time before the discovery of the other special races that ultimately drove it into a position of secondary importance. It was that discovery, in fact, that gave the States their supremacy and caused the area of production to move to the south and west.

Short-staple American.

From the practical standpoint it is essential, therefore, that a clear conception be obtained of the plant which in all probability was the species that first attracted the attention of European manufacturers. Dr. Roxburgh—one of the most accurate of botanists—described and prepared an MS. drawing of an Indian plant which he accepted as being ***G. herbaceum***, *Linn.*, but in that opinion he was in error, for, if any two cultivated species of ***Gossypium*** can be viewed as distinct, ***G. herbaceum***, *Roxb.*, and ***G. herbaceum***, *Linn.*, are so. As understood by Roxburgh, the Indian plant embraced Dacca Cotton (***G. neglectum***, *Tod.*), also the Berar and China Cottons (***G. Nanking***, *Meyen*). It was apparently with the object of primarily separating the Indian country cottons from the Levant plant that Todaro formed his ***G. Wightianum***. That species was founded on but one form (*Oss. Sp. di Cot.*, 1863, No. 12, 47), but subsequently Todaro fell into the error of grouping several Indian plants with it.

Indian Error.

Cultivated Forms.—The forms of ***G. herbaceum***, *Linn.*, that are deemed of greatest value are (*a*) those suited to cold countries, and (*b*) those in the United States that are so much hybridised with ***G. hirsutum*** that they are often accepted as grades of that plant. The large-leaved hairy states of this species require a much warmer climate than the sub-glabrous (and therefore more) typical conditions. Some of the recent writers, such as Cook (*U.S. Dept. Agri. Bull.*, 1906, No. 88, 8), would appear, however, to go to an unnecessary extreme when they affirm, as Cook does, that "the Upland type of cotton was recognised as a distinct species by Linnæus under the name ***G. hirsutum***, but many subsequent writers have erroneously confused the Old World species ***G. herbaceum***, which is not cultivated in the United States, though often so reported." It certainly was very largely cultivated prior to 1732, and for many years thereafter, as the Upland Cotton, and I believe still survives, though mostly in a state of hybridisation with ***G. hirsutum***.

Cultivated Stocks.

D.E.P., iv., 5 7.
Tree Cotton: Nurma.

G. arboreum, *Linn.*, *Sp. Pl.*, 1753, ii., 693 (excl. *syn.* Rheede); Todaro, *Relaz. Cult. dei Cot.*, 1877, 176-80, t. IA; Aliotta, *Riv. Crit. Gen. Goss.*, 1903, 56-65 (in part); Watt, *l.c.* 81-91, tt. 7, 8. Tree Cotton of India and Africa, *deo kapás*, *nurma*, *manua*, *bajwara*, *red navsari*, *ram kapas*, etc.

Habitat.—A small tree or large shrub which has often been claimed as originally an African species, but few botanists have discovered it anywhere in what could be regarded as an indigenous habitat. It has been reported as wild in Upper Guinea, Abyssinia, and Upper Egypt. [*Cf.* De Candolle, *Orig. Cult. Plants*, 405.] Certainly so far as botanical publications are concerned it was figured and described by Alpinus as an Egyptian plant a hundred years before Plukenet wrote of it, "*Gossypium herbaceum maderaspatense.*" It is said to be met with in gardens (especially near temples) in Egypt, Africa, Arabia, India, but though much less abundant has also been found in China, Japan, Java and the Malaya. Lamarck (quoting Sonnerat, *Hist. Voy.*, x., 460), speaks of it as growing plentifully in the plains of Macassar. So far as presently known, the arboreous

India and Africa.

form (which may be called the typical condition) can hardly be said to be cultivated as a source of fibre to-day, though according to Indian tradition it is the cotton that should be selected in preparing the Brahmanical string, and has often been affirmed was also the cotton specially used by the Egyptian priests in the construction of their robes. Many of the Arab writers speak of its fibre as spun and woven. The classic records of a "tree-cotton" carry us many centuries beyond the first mention of a herbaceous field crop, and what is even more curious still, most of the early writers on Indian cottons, such as Rheede, Terry, Rumphius, etc., describe and figure "tree-cottons" (from admitted personal knowledge), but say absolutely nothing about herbaceous field cottons.

Cultivated Forms.

Cultivated Forms.—I regard this species as embracing several fairly distinct forms, some of which at least have been assigned independent positions by certain authors. But while in these a natural assemblage of characteristics is preserved, hardly any one feature is constant. Thus, for example, the flowers may be yellow, the leaves may be very considerably hairy, and the velvet of the seeds may be grey or brown. The more arboreous form occurs chiefly (so far as India is concerned) as an ornamental garden plant. When grown as a field crop ***G. arboreum*** may be either an annual or perennial, and in the latter case is generally sown in rows, being thus employed to shade more delicate annual cottons or other plants. Moreover, the agricultural forms are so much modified, very possibly by hybridisation, that they cannot be regarded as constituting varieties—in fact, many of them are but climatic sports that lose their properties on being carried from one region to another. It may be accepted, accordingly, that in India at least the cultivation of ***G. arboreum*** is quite as ancient, if not more ancient, than that of any other cotton. Some of the Indian races referable to this species (primarily) may be regarded as having derived from ***G. arboreum*** the soft silky character of their flosses, while the length and strength of their staples have come from the other ancestral elements. In others a strain from ***G. arboreum*** would seem to have been sought on account of the strength thus imparted to withstand seasonal climatic changes—the plant for the most part becoming a hardy perennial.

Climatic Sports.

There are many cultivated states of this species found all over India, Egypt and Africa. As already explained, these manifest a constant tendency to throw back towards the arborescent condition with dark purple flowers, whenever they are allowed to become perennial or to be naturalised. The following are some of the more remarkable varieties or cultivated races of this species:—

Red-flowered Cotton.

Var. sanguinea, *Watt, l.c.* 91–5, t. 9; *G. sanguineum, Hassk., Cat. Hort. Bog.*, 200; Todaro, *Relaz. Cult. dei Cot.*, 1877–8, 179, t. 1. This form is rarely met with in India, though frequent in Africa. A red-flowered herbaceous field cotton was, however, at one time common in India, and is occasionally still met with in Oudh. Buchanan-Hamilton, who gave special attention to the subject of the Indian cottons, did not apparently preserve a specimen of ***G. arboreum*** proper in his herbarium. Sets of his plants are to be seen in the Kew, the British Museum, the Wallichian and more especially in the Edinburgh herbaria, and among these may be discovered admirable samples of a red-flowered herbaceous plant which botanically is derived almost immediately from ***G. arboreum***, with possibly a strain of ***G. Nanking***. Of that plant Buchanan-Hamilton has recorded the following observation:—"*No.* 1549, *G. nigrum, vide Comment. meum in Hort. Mal. p. primam. var.* (*a*) *rubicundum ; G. indicum, Willd., Sp. Pl.*, iii., 803 ? *Colitur ubique in India vulgatissima.*" Now if the plant shown by that specimen was cultivated everywhere in India and very common in 1808, it must, I fear, be spoken of as very nearly unknown to-day and its place taken by a multitude of forms of yellow-flowered plants considerably more remote from ***G. arboreum***, *Linn.* Of these may be mentioned:—

Bengal Cotton.

Var. neglecta, *Watt, l.c.* 95–108, tt. 10–12; *G. neglectum, Tod., Relaz. Cult. dei Cot.*, 1877, 169–75; *Cudu Pariti* (*Alcea Malabarensis*), *Rheede, Hort. Mal.*, 1686, i., 55, t. 31; *G. herbaceum, Roxb., Fl. Ind.*, iii., 184; also *Dacca Cotton MS.*, plate in Kew; *G. viridescens, Buch.-Ham. MS.*; *G. herbaceum, Maxwell Masters, Fl. Br. Ind.*, i., 346 (in part); *G. herbaceum, Duthie & Fuller, Field and Garden Crops*, 1882, i., 75–8, t. 18; *G. arboreum, Engler & Prantl, Pflanzenfam.*, 1895, iii., No. 6, 52, f. 25 (after Parl); *G. neglectum, Subbiah, Bull. Dept. Agri. U.Prov.*, 1901, No. 15, 26, t. 1. Bengal Cotton, *belati-*, *vilayati-Khandesh*, *kateli*, *mathi*, *jari*, etc., etc., and is the *okra* of American writers.

Habitat.—A large pyramidal bush, chiefly grown as a field crop. Cultivated throughout Bengal, Assam and the United Provinces, less abundant in South India and Burma, distributed by cultivation to Africa, the West Indies and China. The names given to this plant, and the traditions of the people of India regarding it, suggest its having originated in the drier tracts of the Gangetic basin. Recently it has been carried to all the regions where the perennial cottons (presumably of ***G. Nanking*** origin) formerly prevailed, and the craving for a short cheap staple has even seen its attempted cultivation in Gujarat and Kathiawar—the home of what may be characterised as the long-staple cottons of India.

Early Records.

In point of historic sequence, the earliest botanic reference to this plant would appear to be that in the *Hortus Malabaricus* (1686), thus associating it with India, the headquarters of its present-day cultivation. Rheede speaks of it as a shrub 10 to 12 feet in height, found growing in sandy places. But as if to remove the possibility of its being supposed to be ***G. arboreum***, he carefully describes the long, narrow segments of its smooth, soft leaves, and then adds that the flowers are pale yellow with purple claws and the seeds have a white to grey fuzz. Buchanan-Hamilton, who wrote a commentary on Rheede's great work in 1822, and had himself visited Malabar, observed that so far as he had seen in that district, cotton was raised (as Rheede had described it) by the Natives in the form of small trees planted in corners of gardens and not in fields, nor was the cotton for sale. But Buchanan-Hamilton, unfortunately, had come to the conclusion that all the cultivated cottons of India were mere races that differ from each other vastly less than do the varieties of the cabbage. He thus did not allow himself to realise that even accepting so restricted a botanical view, they might still be of great agricultural and commercial value, and therefore worthy of separate recognition. Accordingly, he omitted to add that the cotton of Malabar might be described as a perennial state of the self-same plant to which he had at one time assigned the name *G. viridescens.* On the other hand, Roxburgh, commenting on Rheede's *Cudu pariti*, observed that he could not bring himself to believe that it was ***G. arboreum.*** The fact that it was a small tree and thus a perennial precluded him apparently from assigning it its true position along with the "Bengal and Dacca Cottons," to which he most unfortunately gave the name *G. herbaceum.*

Restricted Botanical View.

Races.

The cultivated races of this plant known to exist in India are very numerous and much diversified as to yield and merit of staple. Perhaps the most significant feature of the story of this variety is that while to-day it affords the most inferior grades of Asiatic cottons, at one time it seems to have yielded several superior staples. Of these may be mentioned the much-talked-of Dacca cotton.

Dacca Cotton.

Garo Cotton.

Var. assamica, *Watt, l.c.* 108–12, t. 13; Darrah, *Note on Cotton in Assam*, 1885; Middleton, *Agri. Ledg.*, 1895, No. 8, 19–20; *G. cernuum, Todaro, Oss. Sp. di Cot.*, 1863, 31; Garo Hills Cotton, *kil* or *borkapah* (large cotton), *khungi deva*, etc.

This very remarkable cotton might fairly well be described as an extreme form of *var.* ***neglecta.*** It is raised as an annual crop by the people of the Garo hills, who use it in the fabrication of a peculiar kind of blanket, which is formed by rows of tufts of the wool placed by hand across the fabric and bound in that position by the weft being forced home on each such row. Whether this peculiar textile suggested the selection that has resulted in the production of the Garo hills long-boll cotton, it is difficult to say. Certain it is that when carried to other parts of India the plant throws off most of the characteristic features above indicated and becomes a large form of *var.* ***neglecta,*** or perhaps rather of *var.* ***rosea.***

Varadi Cotton.

Var. rosea, *Watt, l.c.* 112–4, t. 14; *G. roseum, Tod., Relaz. Cult. dei Cot.*, 164–8, t. 2; *Nurdki Cotton*, Middleton, *l.c.* 11; *G. roseum, Gammie, Ind. Cot.*, 1905. The *varadi, katil belati, nimari, bangai* (Sylhet), and *nurdki* (Bengal).

This is in reality but an extreme form of ***G. arboreum,*** *Linn., var.* ***neglecta.*** When shown a typical example of this plant by itself (such as Wight's No. 213 from Coimbatore) there is little difficulty in admitting it to a varietal position. But when the study is extended to the cotton fields it is found that the transition into the ordinary form of *var.* ***neglecta*** is so gradual and continuous that it is impossible to separate the two. In fact, the so-called acclimatised Garo hills cotton of Nagpur might even more accurately be described as the present plant. The cultivators of India, being familiar with the normal condition, had brought to them this robust and hardy plant with its small pink-coloured flowers and large bolls, and they at once gave it distinctive names, such as those mentioned above. It is the most inferior of all Indian cottons, though the most prolific yielder.

Prolific Low-grade.

The advance of the *varadi* cotton across India might be said to have been some few years ago regularly chronicled from district to district and hailed as a treasure by the advocates of low grade cottons, while viewed as a calamity by others. Middleton says: "White-flowered cotton is a dangerous rival to the finer varieties. By nature it is made to supplant. When brought to a new district, instead of pining as most exiled cottons do, it develops all its best properties, grows robust, matures early, is prolific and so wins the favour of the cultivators; once established, it begins to degenerate, joins company with the worst of the native varieties, and forms the mixed growths that constitute the bulk of the '*Bengals*' of commerce."

Hybrid sent to India.

It is most curious that the name *vilayati*, often given to this as also to other robust races of ***G. arboreum***, *var.* ***neglecta***, should have begun to be used in Khandesh and Berar about the very time that the record exists of Major Trevor Clarke having supplied seed of a cross he had effected between the Garo hills cotton and Hinganghat. It is thus fairly certain that one of the first serious efforts to improve the Indian stock gave to the cotton growers of that country their most prolific though most inferior staple-yielding plant.

D.E.P., iv., 29. Chinese Cotton.

G. Nanking, *Meyen, Reise*, 1836, ii., 323; *Verh. der Gartenb. der Preuss. Staat.*, xi., 258, t. 3; Watt, *l.c.* 114–24, t. 15; *G. Capas, Rumphius, Herb. Amb.*, 1750, iv., 33–7, t. 12; *G. indicum, Lamk., Encycl.*, 1786, ii., 134; *G. herbaceum, Roxb., Fl. Ind.*, 1832, iii., 184–5 (*var. China Cotton*); *G. herbaceum, Parl., Sp. Cot.*, 32 (in part); *G. Nanking and G. indicum, Todaro, Relaz. Cult. dei Cot.*, 147–52, t. iii., f. 1; *G. herbaceum, var. lana rufa, Aliotta, Riv. Crit. Gen. Goss.*, 1903, 71. The Siam, Chinese and Japanese Cottons of commerce.

Habitat.—An annual or perennial bush with delicately formed and often purple-coloured twigs; cultivated in China, Japan, the Malaya, Siam, Burma, India, the North-West Himalaya, Persia, Central Asia, Celebes, Upper Egypt and Africa (doubtfully in Madagascar and Arabia). No person has recorded the discovery of the wild state of this protean species, and yet its specific characteristics are so constant with many of the cottons, within a large part of the areas indicated, that the separation of the assemblage, from ***G. herbaceum***, ***G. arboreum***, and ***G. obtusifolium***, not only meets a commercial necessity but coincides with many historic facts of importance.

Early Records.

Trigault (1615) says that cotton grows in great abundance but is not indigenous to China, in fact was introduced (? from Egypt) about four hundred years before his time. Dampier (*Voyages*, 1691) speaks of having seen a small cotton plant on an island near Formosa. One of the most interesting of the early writers on Chinese Cotton may be said to be Barrow (*Travels in China*, 1806 (2nd ed.), 556–7, 560). He tells us that the beautiful coloured cotton, known in commerce by the name of the chief city Nanking, was exported, the Chinese purchasing in exchange the cheaper white cottons of Bengal and Bombay. It was, he remarks, planted in rows and grew for three years, thereafter being uprooted and the fields prepared for other crops. Fortune (*Three Years' Wanderings in China*, 1847, 264) explains that the *kakhi* or Nanking cotton was a mere sport from the common white cotton of China.

Races.

Economically ***G. Nanking*** is, at the present day, doubtless much more valuable than *var.* ***sanguinea*** or any of the other ***G. arboreum*** forms. Moreover, some of the ***G. Nanking*** series display characters of far greater interest than the mere length of the corolla (which Todaro lays stress on), and they might, in fact, be broken up into several varieties or distinctive races. Thus, for example, Bretschneider's specimen has the seeds black and almost devoid of an under-velvet—a character which brings to mind the naked black-seeded so-called indigenous cottons of South India (see below), but it is highly probable that both these may have to be regarded as indicating hybridisation with one of the naked-seeded forms. So again, some of the Indian examples of this species have purple flowers, others yellow with purple blotches, and in still others the flowers are pale yellow with a purple tinge on the extremities of the petals. A range of variability such as that can be best accounted for on the assumption that the assemblage embraces many cultivated races, of which each very possibly owes its peculiarities largely to hybridisation.

Hybrids.

Varieties.

Cultivated Forms.—It would be rash to affirm (in the present state of know-

Coconada

ledge) that the special cultivated states to which *G. Nanking* may be referred constitute definite varieties that can readily and invariably be separated from each other. The point of importance is that within certain fairly well defined areas there are commercially and agriculturally distinctive cottons that would appear to be states or races of *G. Nanking*. A detailed acquaintance with the cultivated cottons of Egypt, China, Japan, Siam, the Malaya, etc., will in the future doubtless suggest varietal or racial groups, in amplification of the Indian series here dealt with : —

Red-coloured Cotton.

Var. rubicunda, *Watt, l.c.* 126–8, tt. 17, 18; *G. rubicunda, Roxb. MS.*; *G. obtusifolium, Burkill* (in part), *Mem. Dept. Agri. Ind.*, i., No. 4. This was formerly a much more important plant than it is to-day. It occurs occasionally here and there over the hotter parts of India. Hove, who studied the Indian cottons in the field during 1787, wrote of Cambay, on November 6, that the cottons were then in full bloom with scarlet flowers and quite another species from the yellow-flowered bush grown at Diroll in Broach. "On my journey," he continues, "to Kerwan in Cambay, for the space of sixteen miles, wherever I cast my eye, I could see nothing else but cotton plantations. Where the soil consisted of a heavy clay those districts were planted with the yellow sort, and those which consisted of sand, or were situated higher from the adjacent ground, were planted with the red species." He then gives particulars of the method of propagation, more especially the pruning of the perennial plants. Pruning as a system of improving staple is alluded to by many of the early travellers. At Desborah in Broach, Hove was told, the red cotton was known as *dyva nerma capass*. One of the most remarkable features of Hove's account of the Bombay cotton cultivation, one hundred and twenty years ago, is the stress he lays upon the necessity for free irrigation with yellow-flowered cotton, which in this respect differs, he adds, materially from the red.

Pruning Cotton.

It is significant that all the best examples of *var. rubicunda* in the Kew, British Museum and Edinburgh herbaria appear to have been obtained from South and West or North-West India. It might be described as a hybrid from *G. Nanking* or *G. obtusifolium*. Its place seems to have been taken in Madras and the Deccan, to a very large extent, and possibly quite recently, by the yellow-flowered *bani* and *nadam* cottons.

Hill Cotton.

Var. himalayana, *Watt, l.c.* 124–6, t. 16. A herbaceous annual or biennial yellow-flowered cultivated cotton. This is one of the chief forms grown along the Himalaya, and on some of the lower hills of India proper. It is generally called *bagar* or *watni* cotton. It seems probable that the Chinese and Japanese plant yields a superior staple to any of its Indian representatives; on this account, and because the true *G. Nanking* has repeatedly been introduced into India (*cf.* Roxburgh), it seems desirable to separate the Indian from the Chinese plant. In the Indian form, the leaves are large and broad, the lobes triangular acuminate, and the base very often almost cordate, while the whole plant is frequently very hairy—a departure from the type that possibly denotes hybridisation with *G. obtusifolium*.

D.E.P., iv., 101-2.
Coconada Cotton.

Var. Nadam, *Watt, l.c.* 128–31; *Capas, Rumphius, Herb. Amb.*, iv., 33–7, t. 12; Middleton, *Agri. Ledg.*, 1895, No. 89, 8; *G. indicum, Gammie, Ind. Cottons*, 1905, 6, pl. ix. In trade the cotton of this assemblage is often designated "Coconada," and besides *nadam* there are several other vernacular names that denote the series, such as *yerra* (red) also *paira, burada*, etc. They are usually perennial, bushy plants, with dark-green foliage and deep-red coloured stems. The chief staple of Burma, the *wa-gale*, is an annual; the *wa-ni*, according to Burkill, is a *kakhi*-coloured *wa-gale*; lastly, the *wa-gyi* is a perennial—they are all three states of this variety.

I adopt the name *nadam* (or *yerra*) because it is that ascribed by the Natives of India to one of the most extensively cultivated representatives of the present series of cottons—the *nadam* (or *paira* or *burada*) cottons of South India. Middleton speaks of it as the *roji* of Madras, but he might also have added, or the *bani* of Central and Northern India. There is, however, a considerable range within even the *nadams*. Generally speaking they are the inferior cottons of the Madras Presidency; have often flowers pink in bud and turning reddish purple with age (hence called *yerra* cottons); they are sown either during the north-east monsoon (September to November) or during the south-west monsoon (from April to June), and occupy the land from three to five or more years. They begin to bear in about nine months after sowing, and yield two harvests in their second year, viz. the one in September and the other in January. They are mostly grown on red sandy or stony soils, very rarely on black soils. They are for the most part perennials, and as such attain a height of 6 to 8 feet; they are accordingly largely cultivated as mixed crops, being grown in rows through the fields or as hedges to protect other crops.

D.E.P., iv., 88,129. Hinganghat Cotton.

Var. Bani, *Watt, l.c.* 131–4; Middleton, *l.c.* pl. iii.; *G. herbaceum, var. Jethi, Gammie, l.c.* 4, pl. iv. This affords the finest and most silky qualities of the cottons known in trade as the *Oomras* (Amraoti), the Hinganghats, the Nagpurs and Bihars. Under each of these there are usually two grades, viz. the *bani* and the *jari*. The former grows on the higher and drier soils, especially of the southern districts; gives a fine silky floss but low yield. The latter is raised on the lower black soils of the northern districts; gives an inferior staple of a woolly character but does so very profusely. *Jari* seems originally to have been simply a lower quality of *bani*, and produced possibly by crossing it with *var.* ***neglecta***; nowadays it is pure ***neglecta***. To the circumstance of ***Bani*** being one of the races of the Chinese cotton plant is due its silky staple. The description of the shape of the leaves and colour of the flowers of this special form is almost precisely that given for ***Nadam***, except that the leaves in the finest grades of *bani* are much larger, thinner in texture, more undulated and much more hairy. The bracteoles are usually very large purple entire, or with a few long pointed teeth.

Local Manifestations.

It is met with over a wide area, bears numerous distinctive names, and manifests a considerable range in quality of staple. It mingles with the ***Nadam*** cottons of the south and east, with the ***Roji*** of the west, and with the ***himalayana*** cottons of the north. It is known in Bihar as *jethi* or *desi* (*deshila*); in Bengal proper it is *bhoglla*; in Berar it has numerous synonyms such as *tidki, judi*; in Hyderabad one of the best forms is that produced at Bhainsi; in Southern Kathiawar it seems also to be known by the names of *mathio, tiffina, gangri,* etc. It occurs in Berar, the Central Provinces, Bihar and the drier tracts of Bengal. It is essentially the best cotton met with on all the dry soils that have to be classed as second best in cotton-production.

Roji.

Var. Roji, *Watt, l.c.* 134–7. A perennial, bushy, yellow-flowered, cultivated cotton that might be described as specially prevalent in Baroda and Khaira. It is a tall much-branched shrub, often climbing in hedges 6 to 8 feet with straight ascending branches. When left to grow in the hedgerows *roji* becomes subscandent, the wool shortens and turns rufous-coloured, and the fuzz lengthens and becomes also red-coloured. If allowed to remain in the fields for more than three or four seasons the wool degenerates in quality and, as stated by the early authors, is then fit for upholstery purposes only. But Middleton observes, "*Roji* is markedly different from the annual cottons and does not seem to hybridise with them."

Early Records.

One of the earliest and perhaps the most interesting direct allusions to this cotton is that given by the Rev. E. Terry, who accompanied Sir Thomas Roe's Embassy to India (*Voy. E. Ind.*, 1615, 368). Speaking of the neighbourhood of Surat, he says: " For their Cotton-wooll, they sow seed, and very large quantities of Ground in East-India are thus seeded. It grows up like small Rose-bushes and then puts forth many yellow blossoms. . . . Amongst that Wool they find seeds to sow again as they have occasion; but those shrubs bear that Wool three or four years ere they supplant them. Of this Cotton-wool they make divers sorts of white Cloth." This recalls at once the description of Indian cotton given by Theophrastus (see p. 571).

There is only one perennial cotton with yellow blossoms in Gujarat, and accordingly it seems safe to assume it was the plant to which Terry referred. Here, then, we have another indication that the perennial cottons were once upon a time more largely cultivated than they are to-day, if we are not justified in believing that the perennial cottons were the early condition, the annual plant a later product of greater skill in cultivation. Hove (170 years after Terry's time) repeatedly alludes to perennial cotton seen by him—both red and yellow flowered—but he also gives a full account of the cultivation of the annual plant, and devotes special attention to what he calls a new method recently introduced. This may possibly point to the extended cultivation of the annual crop. But by the date of Hove's visit the *roji* cotton had been assigned the secondary position which it has since held. Hove's actual specimens are in the British Museum, and it has to be admitted that they could not be separated botanically from any corresponding set of more recent date. But he has no sample of what

Change i Indian Stock.

could be called a high-grade *kahnami*, his nearest approach to that being a specimen that might be described as the *wagria* cotton of to-day.

To conclude this account of the forms of ***G. Nanking***, it may have been observed that I have not attempted to describe the races that might be mentioned as examples of each of the great groups, ***Nadam*, *Bani*, *Roji*** and ***himalayana***. But it is next to impossible to furnish descriptions that would be intelligible to persons who have not a personal acquaintance with the living plants. To the cultivators of India they are, however, often of considerable value. Into one or other of the varieties of ***G. Nanking*** have to be placed all the yellow-flowered perennial cottons with thick leathery, broad, five-lobed, imperfectly cordate leaves, having three glands and large ovate acute, thick-toothed bracteoles.

D.E.P., iv., 27. Indian Wild Cotton.

G. obtusifolium, *Roxb.*, *Fl. Ind.*, 1832, iii., 183; Todaro, *Relaz. Cult. dei Cot.*, 1877–8, 129–30; Watt, *l.c.* 139–43, tt. 19, 20; *G. herbaceum, Aliotta*, *Riv. Crit. Gen. Goss.*, 1903, 67.

A shrubby very ramous plant with small *leaves*, having three, more rarely five, obtuse entire lobes, stipules falcate; *bracteoles* entire; *capsule* ovate, cells 3-seeded; *seeds* free, clothed with firmly adhering short greenish-grey down, under a small portion of ash-coloured wool. A native of Ceylon, but not cultivated. Flowered during the rains and cold season in the Botanic Gardens at Calcutta, where it was cultivated from seed obtained from Ceylon of a plant reported to be there wild.

The above, very slightly abbreviated, is Roxburgh's original account of this species. The additional information available may be said to consist of a manuscript coloured drawing made under Roxburgh's supervision and named by him, the original of which is in the Calcutta Herbarium, and an exact copy in the Royal Herbarium, Kew. It is, however, the plant called ***G. herbaceum*** by most writers who have described the cottons of India and Africa, and is the ***G. hirsutum***, *Linn. Herb.*, but not of *Linn.*, *Sp. Pl.* Roxburgh was apparently not aware that it was a wild plant in Khandesh and Gujarat, nor that it was the type of the most important cottons of India. Under the name ***G. herbaceum*** he described the plant now accepted as ***G. arboreum***, *var.* ***neglecta***, and linked that with ***G. Nanking*** (China and Berar Cottons), but kept all three distinct from ***G. obtusifolium***. [No plant that could be supposed to correspond with ***G. obtusifolium*** is, however, mentioned in *Linn, Sp. Pl.*; in *Fl. Zeyl.*; in Burmann, *Thes. Zeyl.*; in Rheede, *Hort. Mal.*; nor in Rumphius, *Herb. Amb.*, etc., etc.] Lastly, Trimen says there is no indigenous cotton in Ceylon.

Feral Condition

Habitat.—A distinctly Oriental species, the various manifestations of which are met with in India, Ceylon, Malay Archipelago, Philippine Islands, Africa and Upper Egypt. I have in India repeatedly collected a ***Gossypium*** in a wild or self-sown condition, and was, I believe, the first person definitely to suggest its identity with ***G. obtusifolium***. It occurs, for example, here and there all over Kathiawar. It is fairly common in the hedges of Gujarat, and was found by me in Khandesh and in the Deccan. If in all these instances it has to be regarded as but a survival of former cultivation, there would seem every likelihood that in some of its known habitats it has existed in the feral condition for a great many years, perhaps centuries. Further, the plant is perfectly easily recognised from all the other Indian cottons, though certain states of ***G. Nanking*** come very near to it indeed, if such instances are not hybrids between the two species. But the plant does not seem to be confined to India and Africa. Vidal collected it in the Island of Ticao, Philippines, and the label attached to his specimen describes it as "wild." So also Dr. A. B. Meyer found it in the Malay Archipelago.

Cultivated Forms.—To distinguish the cultivated forms collectively, of this species, from those of Africa and other parts of the world, it may be useful to group them as embraced under a special Indian variety as follows:—

Indian Long Staples.

Var. Wightiana, *Watt, l.c.* 143–53, tt. 21, 22; *G. Wightianum, Todaro, Oss. Sp. dei Cot.*, 1863, 47–51; also *Relaz. Cult. dei Cot.*, 1877, 141–6 (in part), t. iv., ff. 1–9; *G. hirsutum, Linn.*, *Syst. Nat.*, 1767, ii., 462; also in *Herb.*, *non Sp. Pl.*; *G. herbaceum, Linn., var. obtusifolium, Roxb.*, Wight, *Ic.*, t. 9; Maxwell T. Masters, *Fl. Br. Ind.*, i., 346 (in part); *G. herbaceum, Aliotta*, in *Riv. Crit. Gen. Goss.*, 1903, 67 (in part). The so-called Long-staple Cottons of India.

One of the most remarkable features of this plant is the circumstance that while it is the most valuable of all Indian cottons to-day, it is the one least understood and last of all to have been described by botanists. It is a cultivated annual cotton, with seeds much smaller, more definitely and compactly formed than in the wild plant, and fuzz very short, usually ashy-grey in colour. The change in the shape and size of the seed is a direct result of selection intended to lower percentage weight of seed to floss (lint). Varthéma (*Travels* (ed. Hakl. Soc.), 1510, 107) speaks of the cotton of Cambay being much exported; he also says Bengal cotton is sent to Mecca, and in a footnote mentions the cotton of Burma. Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.*, 1638–40, many passages) makes frequent mention of the cotton of Gujarat and Agra, but not in such a way as to allow any opinions being formed regarding the plant that was then grown. In Milburn's *Oriental Commerce* (1813, i., 280) special mention is made of the Ahmood being at that time the finest grade of Gujarat cotton.

Early Records.

Habitat.—This is cultivated in a belt of country that fringes the west coast of India from the Rann of Kach through Kathiawar and Gujarat, to the southern Maráthá country and South India.

Cotton Areas.

Soils.—The cultivated states of ***G. obtusifolium*** are exceedingly difficult to classify, since they blend almost imperceptibly from one type to another, in direct adaptation to smaller and less conspicuous climatic and soil variations than is experienced in the other cotton areas. There are in India three main classes of cotton soils with three corresponding main groups of cotton plants:—(*a*) Rich black loamy soils, such as those of Kathiawar, Gujarat, Khandesh or the Karnátak. These are collectively often spoken of as the "Black Cotton Soils." (*b*) Mixed red and black stony soils, such as those of the Deccan, Berar, the Central Provinces, etc. (*c*) Alluvial sandy soils such as those in the Ganges and Indus basins. Within (*a*) the forms of ***G. obtusifolium*** are mainly grown; (*b*) of ***G. Nanking***; and (*c*) of ***G. arboreum***. But in each one of these great cotton areas there may be local modifications both in climate, soil, exposure, etc., so that a limited cultivation of all three plants may exist or be possible in any one province. Speaking generally, however, ***G. Nanking***, when met with on the black cotton soils, is of a superior quality to that seen anywhere else and ***G. arboreum*** is there very nearly unknown. These soils are too valuable to be used for the inferior grades, and consequently it is within ***G. obtusifolium*** itself, as a rule, that the adaptations of plant to environment have taken place. On the red and black stony soils ***G. obtusifolium*** rapidly degenerates or becomes hybridised with ***G. Nanking***. In the areas of sandy dry soils ***G. obtusifolium*** becomes unknown, and the higher grades there met with are some of the stocks or hybrids of ***G. Nanking***. It is not to be wondered at, therefore, that in regions so eminently suited for cotton as those possessed of black cotton soils, every little variation in soil, climate, altitude, marine influence, etc., etc., should have resulted in the production of special forms adapted, district by district, if not field by field. The most favoured conditions, and the localities accordingly of the finest Indian staples, are Surat, Broach, Ahmedabad and Kathiawar. But within even these four districts there are well-marked minor areas that have apparently directly originated some of the special forms of ***G. obtusifolium*** that have presently to be indicated. In 1891, and again in 1894, I had the pleasure of studying the cottons of Gujarat practically, on the last occasion in company with Prof. Middleton, now of the Board of Agriculture, who was at that time in the service of His Highness the Maharajah of Baroda. We marched over the greater part of the province as well as Kathiawar (when the cottons were in flower), and Middleton's great personal knowledge of the country enabled him not only to point out to me the kaleidoscopic blendings of the plants, but the immediate relationship of these to the variations in soil. [*Cf. Ann. Rept. Ind. Mus. Calc.*, 1893–4, 2–5.] The rich, deep black soil of Broach and Navsari is known as the *kahnam*, and this was observed to yield the finest of all Indian cottons, accordingly known as the *kahnami* or Broach *deshi* (= country). The districts south-east of Baroda were seen to produce a considerably lower grade of *kahnami* cotton. So also both sides of the Dhadar river (between Baroda and Broach) were noted to change into a calcareous loam with the appearance of a distinctive plant known as the *goghari*. That particular cotton thus occupies an intermediate zone between the plants of the deep black *kahnam* soil proper and the lighter or shallower soils known as *goradu* to the north and west. On these lighter loamy soils are to be found the *kanvi* cottons of Bhavnagar, Palitana, Dhola, Amreli and Junagardh, the *ambli* (of Dhollera), and the *wagria* of Wadhwan, Viramgam, Morvi, North Kathiawar and Kach.

Chief Localities.

Kahnam Soil.

A similar classification doubtless prevails in the southern Maráthá country.

Hybrids

The *kumpta* (*coompta*) cottons of Dharwar and Belgaum are the southern equivalents of the *kahnami* cottons of Gujarat. Still farther to the South (in the Madras Presidency), the *uppams* of Tinnevelly, Coimbatore, etc., closely correspond with the *goghari* cottons, while the *tellapatti* or *jowari-hatti* (hybrid) cottons of Bellary and Karnul in some respects answer to the *wagria* of North Gujarat.

Races.

The following may be given as the chief cultivated races of this species :—

(*A*) *Pure Races.*

(*a*) **Kahnami** : the *deshi* cottons of Broach, Surat, Navsari, Baroda, etc.

(*b*) **Goghari** : one of the inferior but profitable cottons of Baroda and Broach.

(*c*) **Lalio** : the *deshi* cotton of Ahmedabad and Kathiawar—the Dhollera Cottons.

(*d*) **Kumpta** : the characteristic cotton of the southern Maráthá country and known in trade as "*Coomptas.*"

(*e*) **Uppam** : the long-staple cotton of South India, found mainly in Tinnevelly and Coimbatore.

(*B*) *Hybridised Races.*

(*f*) **Kanvi** : a recently introduced stock that often bears the name of *khanpuri* and is probably a hybrid with ***G. arboreum**, var. **neglecta***.

(*g*) **Wagria** : the Common Cotton of North Gujarat, Kathiawar and Kach ; is probably a hybrid with ***G. Nanking***—hence the breadth of leaf.

(*h*) **Tellapatti** : the black-seeded cotton of South India that is often called *jowari-hatti*, and which is found in Bellary and Karnul.. There would seem little doubt that this is a naturally produced hybrid between the *uppam* and Bourbon cottons.

(B) NEW-WORLD FORMS (OR, RATHER, INDIAN EXOTIC COTTONS).

Exotic Species.

For the purpose of this work it is hardly necessary to deal with every species and variety simply on the ground that at some time or other it may have been grown in India, or may even exist as an acclimatised (wild) plant. It is desirable to confine attention to the forms that can be said to be regularly cultivated, and which, therefore, participate in the supply of cotton that finds its way to market, or which have contributed (by hybridisation) to the production of some of the special races now grown in India. Suffice it to say that every cultivated cotton of any note in the world has at some time or other been experimentally grown in India. In all but two cases these have ultimately, however, come to be regarded as less valuable than the Asiatic stocks ; hence certain forms, being neglected, have escaped into the neighbouring hedgerows or jungles and thus survived to this day, under conditions that have occasioned their being mistaken for indigenous (wild) plants. It may, therefore, serve the present purpose if the exotic cottons of India be discussed under two great groups :—

Classification.

Fuzzy-seeded and *Naked-seeded.*—As already observed, a classification exclusively based on any one structural peculiarity would of necessity be misleading, more especially if the selected character could be shown, as in the present instance, to be very largely a special adaptation to external and variable conditions. The grouping suggested is of value, however, when viewed carefully in conjunction with the assemblage of other characteristics that may be said to demarcate the species. It is, moreover, a simple and convenient method of recognising the more important New World cottons.

Selection.

It may be recollected that the seeds of most wild cottons contain a more or less complete coating of hairs, formed, it is believed, with a view to protection from insect enemies. Certain developments of that feature may, therefore, be regarded as brought into existence primarily as a consequence of definite adaptations, but by human selection these have been fostered or changed in accordance with an altogether new purpose, namely the supply of fibre of a particular length, strength or colour. In some instances, a proportion only of the coating has been elongated, either naturally or as a direct consequence of cultivation. Hence it has come about that the coating of hairs may be referable to two layers—an under coating of short hairs (the fuzz), and an outer coating (the floss). But, on the other hand, the whole of the coating may elongate into floss, the seeds in such cases being described as "naked," that is to say, not possessed of a fuzz. Lastly, the elongation of the floss may not be constant or uniform ; a certain proportion may be shorter than the rest. Want of uniformity in the length of the staple is a serious defect, hence in selection of stock this aspect has to be carefully considered. But now comes a curious circumstance, and one of great practical interest : seeds possessed of a fuzz have, as a rule,

Fuzzy and Naked Seeds.

Necessity for two Kinds of Gins.

Tearing of Staple.

their floss more securely and firmly bound to the seed-coat than is the case with naked seeds. This has led to two classes of gins, namely saw-gins and roller-gins, the former being regarded as necessary to tear the firmly bound fibre from the seed-coat, and the latter sufficient for the naked-seeded cottons. The tearing of the staple is a significant feature that lowers very materially the value of the floss, apart altogether from other considerations. A naked-seeded readily separable floss is, therefore, a high qualification, and one that marks great progression in cotton cultivation.

Fuzzy-seeded Cottons of the New World.—The species that fall into this position are :—

D.E.P., iv., 17-8.

Saw-ginned Dharwar.

G. hirsutum, *Linn.*, *Sp. Pl.* (*non Herb.* and *non Syst. Nat.*), 2nd ed., 1763, 975, founded on Miller, *Gard. Dict.*, 7th ed., 1759, n. 4; *G. latifolium, Murray, Comm. Soc. Reg. Gott.*, 1776, vii., 22-5, t. 1; Watt, *l.c.* 183–200, tt. 29–31. This is possibly a cultivated state of ***G. punctatum, Sch. et Thon.*** (***G. jamaicense, Macf.***).

Miller's Chelsea Stock.

Grown in Georgia.

A botanical specimen contributed by Philip Miller is preserved in the British Museum and is, therefore, very possibly the actual type of the species. Another specimen of the same plant will be found in the Badminton Garden herbarium (also preserved in the British Museum), which was very probably the source from whence Miller obtained seed. And it is just possible the Badminton stock came from Guadeloupe Island, having been contributed by the brothers Lignon, mentioned by Tournefort as having sent seeds of West Indian plants, more especially from Guadeloupe, to Paris. It is interesting, therefore, to be able to add that the record exists of seed having been grown in Georgia in 1734, from a supply furnished by Miller from the Chelsea Physic Garden. There is thus little doubt that the introduction of the actual stock of the New Orleans, Georgian, and many other short-staple American cottons, dates very possibly from the supply sent out by Miller. But to this same plant has to be attributed the Egyptian (Delta lands) cotton—a plant that existed very possibly in Upper Egypt long anterior to the modern traffic, the stock of which we know came very largely from the United States of America. So also the so-called saw-ginned Dharwar cottons of recent Indian commerce were obtained from the States, though later supplies were procured from Egypt, from belief that they represented a special and peculiar plant known in trade as "Egyptian Cotton."

Cultivation in India.

Some years previous to this historic introduction of the Dharwar stock, Roxburgh spoke of the plant having been only of late brought into India. He does not tell us where it came from, but his description occasions no doubt as to its determination, and he was the first botanist to affirm that the seeds were free from each other. Interest was being taken in the plant the world over, however, since towards the close of the 18th century Murray furnished an admirable picture and description of it, under the name *G. latifolium.* During the past fifty or sixty years the cultivation of this cotton in India has gradually concentrated in the Deccan. It is, of course, also met with in other parts of India, but success has chiefly attended its acclimatisation in Dharwar and the neighbouring districts, hence its being known in trade as Saw-ginned Dharwar.

Admixture.

General Appearance.

In 1894 I made a tour on foot through certain districts of the Central Provinces and Berar, in order to study in the field the cottons there cultivated. In many parts of Nagpur, Wardha, Ellichpur, Amraoti and Akola I found the present plant very largely mixed in all the fields of the so-called higher grade "*Oomras.*" In many cases it would not have been an over-estimate to say that they contained from 20 to 30 per cent. of ***G. hirsutum***, the balance being ***G. Nanking**, var. **Bani***, of an inferior stock for the most part. The latter was a much larger and more prolific yielder, and the former was grown, so the cultivators told me, entirely because the mixture was believed to raise the grade of the staple. Except, therefore, in Dharwar, where it is grown as a pure crop, the condition mentioned as discovered in the Central Provinces is characteristic of the occurrence of the present plant in India as a whole. It has, however, greatly degenerated, and is often not more than a foot or a foot and a half in height; is a coarse, stunted, much-branched, erect, greenish-red, dust-coated bush, the last-mentioned peculiarity being a consequence of the abundance, length and strength of the hairs with which the shoots, leaf-stalks and veins are coated. The seeds are always large, ovate, truncated on one extremity and have a strong dense fuzz, which may be grey or green in colour. The floss adheres very firmly, hence necessitating the use of saw-gins, but it is fairly long and silky.

As met with in India, the plant has degenerated very greatly from the standard preserved in the United States and in Egypt—has, in fact, approached in many directions to the specific conditions of ***G. punctatum***, although I am not aware of its ever having been recorded as met with as an escape from cultivation. Had systematic selection of stock been pursued in India, there is little doubt that a higher standard than exists might have been maintained, if not a progression secured. Of this there can be no doubt, that the Upland Cottons of America have advanced until the plant that now affords them is no longer ***G. hirsutum***, but a greatly improved stock that botanically might be described as a hybrid between ***G. hirsutum*** and ***G. mexicanum***.

Religious Cotton.

Var. religiosa, *Watt, l.c.* 201–4, tt. 32, 33; *G. religiosum, Linn., Syst. Nat.*, 1767, ii., 462 (in part); *G. religiosum, Linn. Herb.*; *G. tricuspidatum, Lamk., Encycl.*, ii., 135; *G. croceum, Ham., Trans. Linn. Soc.*, 1822, xiii., 491–4; *G. religiosum, Roxb., Fl. Ind.*, 1832, iii., 185–6, but MS. drawing n. 1497 is named *G. fuscum*.

This somewhat remarkable plant is mentioned here mainly in order to allow of its separation from ***G. brasiliense*** (which by Parlatore and others has been incorrectly called ***G. religiosum***). It is not of much importance commercially as its separation from ***G. hirsutum*** is a matter of great difficulty, and, moreover, the plant does not appear to be very extensively cultivated. It is best distinguished from the normal condition of saw-ginned Dharwar cotton by its trailing habit and more softly hairy condition. The lateral shoots are much elongated and slender and the internodes are long, straight and profusely tomentose. It is not uncommon to find popular writers in India affirming that the name ***religiosum*** was given to denote a cotton cultivated by mendicants or one met with near temples. The name was first used by Linnæus, and there is no proof whatever that his specimen came from India. Moreover, the plant that in India might deserve the name ***religiosum*** would be the *deo kápas* or *ram-kápas*, which is ***G. arboreum***. Roxburgh was the first botanist who critically studied the plant, and he came to the very correct conclusion that it could "scarcely be more than a variety of ***hirsutum***."

Red Peruvian.

G. microcarpum, *Tod., Hort. Bot. Pan.*, 1876, i., 63, t. 14; Watt, *l.c.* 210–3, t. 36; *Nigro Cotton, Labat, Nouv. Rel. de l'Afrique Occ.*, 1728, iii., 262–9, t. 261.

A remarkable plant met with now and again throughout the cotton areas, more especially in Africa, though the type was described from a plant raised (so Todaro says) from seed procured from Mexico. Its leaves are even more deeply palmisected—the lobes being almost linear—than is the case with ***G. brasiliense***, but they are in addition pilose-tomentose, while the seeds are semi-conglomerated and partially coated with a velvet. One of the most striking peculiarities of this plant is the immense size of the calyx. By most writers this has been confused with kidney cotton (***G. brasiliense***), but others call it the true Pernambuco cotton of commerce, which they hold to be thus distinct from the kidney cotton. By still others it is the original stock of the *ashmouni* cotton of Egypt, an opinion which I do not accept. Perhaps its best popular name is Red Peruvian.

D.E.P., iv., 20–1.
Peruvian and Egyptian.

G. peruvianum, *Cav., Diss.*, 1785–90, 313, t. 168; *G. vitifolium, Roxb., Fl. Ind.*, iii., 186; *? G. religiosum, Parl.* (in part, but *non Linn.*); *G. hirsutum, Cook, Weevil Resist. Adapt. of Cot. Pl.*; Watt, *l.c.* 213–26, tt. 37, 38. *U.S. Dept. Agri. Pl. Indust. Bull.*, 1906, No. 88, 8. Possibly indigenous to Central and South America; is the so-called Peruvian Cotton now met with in most cotton-growing countries, especially West Africa, where it received numerous distinctive local names, such as *owu* of Abbeokuta and *ukoko* of the Congo; and most of the races of ordinary or short-staple Egyptians, such as the *Ashmouni, Mit Afifi, Zafiri* and *Abassi*.

This somewhat obscure species links together ***G. mexicanum*** and ***G. brasiliense***. It has the palmisected foliage of the latter with the blistering habit of twigs and fuzz-coated seeds of the former. It is somewhat significant that all the American and African cultivated cottons that possess seeds more or less coated with a velvet or fuzz (*e.g.* ***G. hirsutum***, ***G. mexicanum*** and ***G. peruvianum***) have the leaves more or less pilose, while the forms with sub-glabrous leaves (*e.g.* ***G. purpurascens***, ***G. vitifolium*** and ***G. brasiliense***) have the seeds practically naked; that is to say, they do not possess a fuzz.

Upland and Georgian.

G. mexicanum, *Tod.*, *Relaz. Cult. dei Cot.*, 193, tt. vi., xii., f. 32; Watt, *l.c.* 226–44, tt. 39–42. This hybrid species is often very difficult to separate from *G. purpurascens* when in foliage. The leaves are broad, smooth, glabrescent with five to seven radiating veins and lobes; peduncles prolonged, pedicels short and flowers small, pale-coloured, nodding; seeds large, with thin ashy fuzz, and copious woolly floss. Apparently originally procured from Mexico, but so far as known is met with under cultivation only.

Introduction into India.

Roxburgh tells us that this was introduced into India by W. Hamilton in 1804, but subsequently he seems to have confused it with Bourbon Cotton (***G. purpurascens***), and gave both plants the botanical name of ***G. barbadense***, *Willd.*, since both his MS. drawings (so named) are in reality ***G. mexicanum***. He further apparently alludes to this plant under ***G. hirsutum*** as being grey-seeded. Wight, Spry and many other Indian writers refer to Mexican Cotton in the Journals of the Agri.-Horticultural Society.

Mexican Cotton.

It has, however, to be admitted that some uncertainty exists as to the plant Todaro actually meant by the name ***G. mexicanum***. If his coloured illustration be accepted arbitrarily as the type, then it has to be confessed that it is not very plentiful in herbaria. In all the samples seen by me that approach most closely to that type, the plants either came from Mexico or were raised from seed procured from that country, as Todaro affirms was the case with the plant figured and described by him. But in all the best tracts of America, from which the finest Upland and Georgian Cottons are procured, the plant there grown is almost exactly intermediate between the type of ***G. hirsutum*** and that of ***G. mexicanum***. The leaves are large and broad in fully-formed conditions, are 5-, sometimes even 7-lobed or only angled. In texture they are smooth, thick, leathery and either very hairy (in forms that approach to ***G. hirsutum***) or almost quite glabrous (in those with a closer approximation to ***G. mexicanum***). In the United States fresh stock has again and again been imported from Mexico, and the admission made that the previously existing stocks had been thereby much improved. There would thus seem little doubt that the improvement that has been consistently reported as taking place has run parallel with an undoubted advancement from the older type of ***G. hirsutum*** towards that which more appropriately should (from the botanical standpoint) be designated ***G. mexicanum***. But they are one and all hybrids, and the suggestion may be offered that they have been derived from ***G. hirsutum*** as the one stock, and either ***G. purpurascens*** or ***G. vitifolium*** (***G. barbadense***) the other—the result being the presumed hybrid condition here designated ***G. mexicanum***. Of the more famed cottons of this assemblage, the following may be specially mentioned as (*a*) hairy (*e.g.* *aff.* ***G. hirsutum***) forms:—"Allen," "Peeler," "Sunflower," "Todd" and "Russell." Of the (*b*) glabrous (*aff.* ***G. mexicanum***):—"Welborn's Pet," "Willet's Red Leaf," "Parker," "Layton's Improved," "Toale," "Shine," "Simms," "Berry's Big Boll," "Culpepper," "Cummings," "Triumph," "Gibson," "Myers" and "Texas Wool." Reversions are also recorded, one example of which may be here specially mentioned, namely "King's Improved," which comes closer to ***G. punctatum*** than to the bulk of the modern ***G. mexicanum*** cottons that to-day are called by the old, but now hardly accurate name of ***G. hirsutum***. Another illustration is the tendency for green-seeded stock (***G. hirsutum*** type proper) to produce brown or grey-seeded forms (***G. mexicanum***) according as the degree of cultivation or neglect tends to develop and establish the one or other ancestor of the present-day much hybridised stock of Upland cottons.

Hybrids.

Special Races.

King's Improved.

Naked-seeded Cottons of the New World.—The following, among other species, may be specially mentioned in this position:—

Bourbon Cotton.

G. purpurascens, *Poir.*, Lamk., *Encycl. Meth. Bot. suppl.*, 1811, ii., 369; Watt, *l.c.* 250–5, t. 44. A cultivated perennial plant of which there are several distinctive races, derived very possibly from ***G. taitense***, *Parl.*, and which constitute the Bourbon and Porto Rico Cottons of commerce.

The seeds are not only what is called naked, but the leaves are almost glabrous. They are perennial plants with strongly angled purplish shoots and leaves ovate entire or with three lobes on the apex, the laterals arching outwards and the petioles almost thorny through the growth of glandular warts. They are all essentially insular plants, hence the greater success attained with them in South as compared with North India. They seem to be readily hybridised, and in consequence it is not uncommon for completely fuzzy seeds to appear among plants raised from the normal condition, viz. the seeds naked, except for a tuft of rust-coloured fuzz around the beak.

D.E.P., iv., 22-3. Vine-leaved Cotton.

G. vitifolium, *Lamk.*, *Encycl. Meth. Bot.*, ii., 135 (excl. syn. *Pluk. Alm.*, t. 188, f. 2, added doubtfully by Lamk.); Watt, *l.c.* 255-65, tt. 1, 45; *Xylon arboreum, Merian, Surin. Insect.*, 1679, t. 10; Labat, *Nouv. Voy. aux Isles de l'Amer.*, 1724, i., pt. 2, 125-31; *G. latifolium, Rumphius, Herb. Amb.*, 1750, iv., 37, t. xiii. (excl. syn.); *G. barbadense, Parl., Sp. dei Cot.*, t. iii. (in part); *G. religiosum, Aliotta, Riv. Crit. Gen. Goss.*, 44 (in part).

The Vine-leaved Cotton was probably originally a native of Central and South America, to the Amazon basin and the Lesser Antilles, but early found under cultivation throughout the cotton area of the world. It is the Egyptian long staple, Antilles, Piura, Surinam and Cayenne, St. Domingo, Guadeloupe, Barbados and other cottons. In the early literature of this genus the greatest possible obscurity prevails regarding ***G. barbadense***. It might, in fact, without fear of contradiction, be affirmed that there was little or no distinction between that species and the present plant. As time advanced the form known as Sea Island Cotton appeared, and to it became restricted, by most authors, the name ***G. barbadense***, leaving ***G. vitifolium*** to be accepted as denoting the slightly lower-grade cottons of South America and Egypt that are classed as "Long Staples." It is, in other words, highly likely that this plant may have been one of the ancestral stocks of ***G. barbadense***, *var.* ***maritima***—a plant which is perhaps the most recent addition to the prized races of cotton met with in the world. No one seems to know what was meant originally by ***G. barbadense***. It nowhere exists in a wild state, and is apparently never cultivated except in the form nowadays called Sea Island, but which could hardly be accepted as ***G. barbadense***, *Linn.* The present plant, on the other hand, exists in numerous forms. It is the vine-leaved cotton of most of the early authors, who repeatedly speak of it as met with wild or completely acclimatised. The *leaves* are sub-cordate with mostly only three ascending lobes, the texture often piloso-tomentose below. The *bracteoles* are very large, ovate rotund, deeply auricled, slightly united below and often possessed of the bractlets described by Cook as weevil-resisting adaptations (*U.S. Dept. Agri. Bureau Pl. Indust.*, 1906, No. 88.) *Seeds* black, naked and quite free from each other.

Long Staple, Egyptian.

Weevil Resistent.

D.E.P., iv., 18-20. Sea Island Cotton.

G. barbadense, *Linn.*, *Hort. Upsal.*, 1748, i., 204; *Sp. Pl.* (1st ed.), 1753, ii., 693; Pluk., *Alm. Bot.*, 1696, ii., 172, and *Phyt.*, t. 188, f. 1. (excl. all syn.); Wight, *Illust. Ind. Bot.*, 1840, i., 57-64, t. 28B; Watt, *l.c.* 265-95, tt. 46-8; Sea Island Cotton.

This embraces all the higher-grade long-staple cottons. A shrubby perennial known only in a state of cultivation, and raised usually as an annual. It is glabrous or nearly so, except on the leaf-stalks and veins and the under-surfaces of young leaves.

As already suggested, there seems every probability that the early authors who accepted the name ***G. barbadense*** did not realise that it meant one and the same plant as that designated ***G. vitifolium***. By cultivation and crossing, however, a highly specialised race, known as "Sea Island," was produced, to which by recent authors the Linnean name ***G. barbadense*** became in time restricted, though Todaro, and following him some other botanists, preferred to give the new stock the name of ***G. maritimum***, thus leaving ***G. barbadense*** as a name for a species presumed by many to exist, but known for certain to no botanical writer. The species founded by Linnæus may be said to turn on a specimen still preserved in the British Museum, and that specimen certainly agrees more closely with *G. vitifolium, Lamk.,* than with the modern Sea Island Cotton of America.

Although repeatedly introduced into India, Sea Island Cotton has, in no locality, proved a success. It is possible, however, that it might be raised profitably in the Andaman and Nicobar Islands and in some parts of Tenasserim.

D.E.P., iv., 23-5. Kidney Cotton.

G. brasiliense, *Macf., Fl. Jam.*, 1837, i., 72; Watt., *l.c.* 295-315, tt. 49, 50; *Bambagia, arborea di Pernambuco, Zanoni, Istoria Bot.*, 1675, 40-4, t. 16; *G. religiosum, Lamk., Cav., Willd., Parl.* and others, *non Linn.*; *G. acuminatum, Roxb., Fl. Ind.*, 1832, iii., 186 and MS. drawing n. 1598 (wrongly named *G. vitifolium*), etc., etc.

Chain Cotton.

The Chain, Kidney, Brazilian, Bahia, Pernambuco and Costa Rica Cottons of most popular writers, and in Burma it is *thembanwa* (ship's cotton). It was first definitely alluded to by John Lerius, who lived in Brazil in 1557, and wrote a history of that country. Sir Walter Elliot, speaking of the plant as known to him in South India, calls it *paidi* (gold) *patti* and *pamidi patti* (the wealth-giving), names that denote the high expectations that were at one time entertained regarding this plant. It was apparently the first of the long-staple silky cottons of the New World to attract attention. Seeds were conveyed by Marcgraf and others, and the chain condition so well figured by Zanoni seems to have been accepted as a peculiarity of all cottons, hence Lobel (1576) thought he improved on the pictures of *G. herbaceum*, given thirty years previously by Fuchsius and Matthiolus, by adding a kidneyed mass of seven seeds.

Introduction to India.

All the nations of the world seem for a time to have vied with each other in the attempt to acclimatise the Brazilian Cotton, and in each new country to which taken it obtained the name of the region from whence immediately conveyed; accordingly in Burma, and also in the Antilles, it is called "Siam Cotton," and in India "Ava Cotton," etc. Roxburgh tells us in the MS. edition of his *Flora Indica* (preserved in Kew) that he became acquainted with it through seed sent him from Farukhabad. Mr. H. St. George Tucker (Member of the Court of Directors of the East India Company) observes that Lady Hastings grew it at Fatteghar, and Roger Hunt, in 1808, addressed the East India Company on the causes of deterioration of Pernambuco and Surinam Cottons. Thus we know that prior to Roxburgh's knowledge of it this plant had been experimentally tried in many parts of India.

Wide Distribution.

It is, therefore, perhaps not to be wondered at that this cotton has got considerably more widely distributed and is moreover more frequently met with in states of acclimatisation than is the case with any of the other New World cottons. Its large capsule, compact mass of seeds and the copious coating of floss naturally conveyed the impression of great value, and false expectations were raised, only to be rudely dispelled by comparisons of yield to acre. Gradually, however, all interest (or nearly so) in this particular Brazilian Cotton died out with the appearance first of the Upland Georgian Cottons, then the Mexican Cottons, and finally the Sea Island Cottons, all races that could be raised as annuals and occupy the soil for short periods. The present species in most countries accordingly fell into a state of complete neglect and either disappeared or survived as an escape from cultivation and became "the wild tree cotton" of most popular writers, the properties of which have been the will-o'-the-wisp of nearly each decade for the past century in the world's cotton areas.

Great Expectations.

If I am correct in believing that this plant, however, represents an important stage in the development of the fine long staples of the West Indies and the Sea Islands of America, it is not by any means devoid of interest to persons interested in the production of new and improved races. But as met with in India to-day it is of no value whatever, and the expectations recently advanced regarding it would accordingly seem almost for certain doomed to disappointment, since opposed to all past experience with the plant. It may be said to have attained commercial importance within very restricted areas. In South America—its indigenous habitat—it is regarded as of special value because of its resistance of the diseases that prove disastrous to other cottons. In Guatemala, for example, it is believed to be immune from weevil.

Little Encouragement to Improve.

Cotton Frauds Act of 1863.

I. ADULTERATION AND DETERIORATION.—Milburn (*Or. Comm.*, 1813, 279–80) urged that it was impossible to be too attentive to the shipping of perfectly clean cotton. The adulteration and deterioration of Indian cotton has thus engaged attention for fully a century. St. George Tucker (to whom reference has been made above) wrote in 1830 a report *On the Supply of Cotton from British India* (*cf Reports on Cotton, Silk, and Indigo* published by the Company in 1836, 152–75) in order to account for its depression in price and deterioration in quality. He gives ten reasons. Royle (*Cult. and Comm. of Cotton in Ind.*, 1851, 551) deals frequently and effectively with this question. "When the cotton," he says, which the Native grows, "is intended for sale, the *ryots* have little enough encouragement to bestow more care, either in growing or in picking their cotton, for they usually get no better price for a good and clean, than they do for an indifferent article." So again, "Indian cotton is, however, from the shortness of staple, not well suited for all the purposes of the English manufacturer; but it is much more depreciated than it need be from the dirty and adulterated state in which it is sent to market." Mention has been made that (about the time of the great cotton famine, 1861–5) notice was forcibly directed to India as a future country of supply for England. An outcry was shortly after made against the adulteration and mixing of inferior with superior grade staples. This led to the passing of the Cotton Frauds Act (IX. of 1863, and the Amendment of 1878, Act VII.).

Adulteration.

W. B. Wishart (Secretary of the Chamber of Commerce of Upper India) published in 1891 a *Note on the Adulteration of Cotton* in which he shows that the subject had agitated the minds of the cotton merchants of India for many years. He points out that a report issued in 1845, for example, gave details of the deterioration and decrease in outturn even then observed. Wishart then remarks: "There is now no *bona fide* market for our inferior cotton. Native hand-weavers cannot work it; the Chinese found out, some years ago, that it did not pay them to use it, and now our Continental customers can and do buy an article that suits them equally well at a proportionately lower price. There is, therefore, no outlet for such cottons, and Native growers and buyers have naturally taken to assisting each other by bulking the inferior and better stuff produced in each district, the mixture constituting a quality just a little below that which spinners want."

Legislation deemed Undesirable.

In August 1891 a conference was held in the office of the Director of Land Records and Agriculture, Poona, at which proposals were made with a view to preserve and improve the quality of Indian cotton. In the same year Sir E. M. James (at that time Commissioner in Sind) drew up a Memorandum on Cotton. This was widely circulated by the Bombay Government, and elicited many valuable opinions and reports. The Chamber of Commerce of Bombay, for example, issued a very powerful reply, dated November 11, which fully expressed the opinion ultimately upheld by the Government, namely that while there was much need for effort at improving the stock, penal legislation was undesirable. Ten years later (Feb. 1901) the Hon. Mr. Bomanjee Petit (himself a prominent mill owner) pressed on the attention, both of the Bombay Government and the Mill Owners' Association, the serious consequences of the deterioration of the Indian cotton staple. It has now actually come about that both China and Japan have begun to produce coarse yarns of their own, and

Necessity to Advance.

Recommendation for declaration of Locality.

have thus commenced to close two of the most important outlets for Indian exports. In consequence the necessity to advance has been borne home on the minds of the Indian mill owners. Instead of spinning as their finest yarns 20's, they have begun to think of 80's, but for this purpose they require to import raw cotton from Egypt, if not even from America. India no longer possesses a cotton suited for that purpose, and the adulteration and mixing of the staple have thus very nearly paralysed the industry. In consequence the outcry for legislation has once more been raised : it has been urged that a law requiring the locality of production to be stamped on all bales of cotton would have a highly beneficial result. Others look to the expectations of Sind, irrigated by a system of canals that may allow of the production of the high-grade Egyptian cottons, as the most hopeful indication of the future.

History repeats Itself.

Retrograde Agriculture.

Thus history repeats itself, in no commodity of commerce with greater regularity than in the theories and practices of cotton growing and cotton trading. One lesson alone seems to stand out through the past decades of the steam-power cotton industry of India as unwavering, viz. the conviction that when the time comes for India to assume once more the rôle of a producing and even exporting country in the finer cotton goods, it must either have improved its staple or discovered a country capable of meeting its necessities in suitable raw fibre. A low-grade staple such as the bulk of that grown in India to-day is utterly unsuited for the higher class machine-made goods, even were it put down at the mills pure and clean at a price below that procurable by any other power mills in the world. Thus it has been shown that cheap production is not necessarily economic production. Expensive labour means higher intelligence, with compensation in quality and price. C. P. Austin (*Cotton Trade of the United States*, 1900, 2608) points out, and with much force, that the low wages of the Indian cultivator are no real economy, since they prevent cotton cultivation on a large scale directed by intelligent supervision. Retrograde agriculture, such as has characterised the Indian cotton trade for a century past, must in the end fall behind in the race for commercial supremacy.

Fuzzy and Naked Seeds.

II. IMPROVEMENT OF STOCK.—The cultivated cottons of the world have been referred to three great areas—(*a*) Asia, (*b*) Africa, and (*c*) America. But it has sometimes been affirmed that the first two can be taken together and spoken of as the fuzzy-seeded Asiatic and the others as the naked-seeded American cottons. But it is not the case that all the fuzzy-seeded species are Asiatic, any more than that all the naked-seeded are American. Moreover, the seeds of wild cottons have either a firmly adhering coating of wool or a readily separable floss. But there are both wild and cultivated cottons that possess both a fuzz and a floss. As already mentioned, Cook (*U.S. Dept. Agri. Bull.*, 1906, No. 88) thinks the wool may be a necessity in the protection of the seed from the enemies of the plant. Certainly in most wild forms, such as ***G. Stocksii,*** and still more so ***G. Davidsonii,*** the wool is so firmly and intricately crumpled up around the seed as to prove a veritable proboscis-proof protection, thus causing such seeds to be described as naked, the compacted fuzz having escaped detection. But of purely wild species the following among others possess a short velvety coating around the seed :—***G. Harknessii*** (a native of California) ; ***G. Palmerii*** (of Mexico) ; ***G. Sturtii*** (of Australia), and ***G. tomentosum*** (of the Hawaiian Islands). On the other hand, the following have naked seeds :—***G. Kirkii*** (of East Tropical

Africa), and ***G. taitense*** (of the Polynesian Islands). In passing it may be here added that no Asiatic indigenous cotton has a naked seed, and further that with the fuzzy-seeded Asiatic forms the bracteoles are united below, whereas with the American fuzzy-seeded cottons the bracteoles are free. The appearance, therefore, of these peculiarities in certain cultivated or long acclimatised plants may safely be regarded as denoting definite influences and not accidental sports or climatic adaptations.

Specific Influences.

Hybridisation.

It has sometimes been upheld, but with little justification, that the crossing of fuzzy-seeded and naked-seeded cottons (or of Asiatic and American cottons) was impossible. But there is perhaps no subject on which greater diversity of opinion exists than in the value or even possibility of hybridisation of the species of ***Gossypium***. One set of writers affirms that it is difficult, if not impossible, to prevent hybridisation, while another stoutly upholds the belief that hybridisation is of no practical value, if they do not indeed go so far as to deny the possibility of its accomplishment in nature. A parallel to this diversity (and perhaps a consequent one) is the degree of acceptance of the species as established by botanists. Some writers, such as Todaro, think there may be as many as 54 species, while others, such as Parlatore, reduce them to 7, and Aliotta to 5 species, with numerous varieties and cultivated races or hybrids under each. Buchanan-Hamilton went further and reduced all to 2 (or perhaps 3) species, viz. the black (naked) seeded and the white (fuzzy) seeded, with as a third the red (*kakhi*) seeded cottons. In fact the controversy regarding the number of species dates even from before the formation botanically of the genus ***Gossypium***, but I venture to think it could never have existed and cannot exist to-day, when the undoubted wild forms are made the basis of classification.

Number of Species.

The confliction as to hybrids may be exemplified by the writings of two of the most recent authors. Aliotta (*Riv. Crit. Gen. Goss.* 1903) gives an elaborate statement of the races of cultivated cottons which he thinks have been produced through the cross-breeding of his five species—***G. barbadense, G. religiosum, G. arboreum, G. herbaceum***, and ***G. hirsutum***. On the other hand, G. A. Gammie, Professor of Botany at Poona, Bombay, in his recent report (*The Indian Cottons*, 1905) reduces all the Indian cultivated forms to ***G. obtusifolium***. He would, moreover, not appear to regard hybridisation as of any practical value whatever. He observes that the so-called species and hybrids are merely cultivated races evolved by time and environment from one prototype, but he nevertheless adds somewhat paradoxically that they are capable of being crossed with facility and that their descendants are fertile.

After many years of careful study of the Indian cottons, both in the field and the herbarium, I am constrained to join issue with Aliotta and writers of his school in thinking hybridisation has played an important rôle, though I am not of course prepared to reduce the ancestral stocks to five forms. Still I am satisfied that many of the more highly prized cultivated cottons are not species botanically (though it may be convenient to retain for them specific names), but are races and natural hybrids (some of the more recent artificial) adapted by selection to man's requirements and to environment. I am at one, in fact, with the army of workers in America who not only say they have produced endless forms by crossing, but who regard that agency as of the greatest possible importance. Tracey (Dabney, *The Cotton Plant*, 1896, 197–224), in dealing with the cultivated varieties, remarks, "Although the plants from a single line of crosses, as fertilising Peterkin with Allen, will vary widely, still it is a general

American Hybrids.

rule that the character and habit of the future plant will be more like those of the female parent, while the fruit, the boll and its contents, will be more like those of the male parent." So again, "The tendency of the plant to vary from the typical form of any variety will be back towards its original form rather than in any other direction." From these and such-like considerations is doubtless due the affirmation that, from one or two plants specially cultivated and as a consequence of careful selection of sports, it might be possible to produce all the chief types of cultivated cottons. Hence it may be said that with few other cultivated plants is a more rigid selection of seed necessary than with cotton. Moreover, there seems little doubt but that historically it can be shown that ***G. hirsutum***, ***G. mexicanum***, ***G. vitifolium*** and ***G. barbadense***, as known to us to-day, are themselves to a large extent hybrid stocks. It does not follow, however, that all hybrids may be fertile, still less that they can be invariably again further hybridised with fresh ancestral influences, according to the fancy of the operator. To the neglect of this consideration may be due much of past failure in hybridisation.

Tendencies of Variation.

Selection.

Spermatogenesis.

One of the most valuable and interesting papers on this subject is that written by Austin Cannon, entitled *Spermatogenesis of Hybrid Cotton* (in *Bull. Torrey Bot. Club*, 1903, xxx., 133–72.) The cotton hybrid experimented on was produced (so we are told) between Sea Island Cotton (Constellation brand) and Upland Cotton (Klondike brand)—***G. barbadense*** × ***G. herbaceum*** and the hybrids were found fertile. It is, however, just possible that the plant spoken of as ***G. herbaceum*** should have been called ***G. hirsutum*** or ***G. mexicanum***, for until about 1896 Uplands were by American authors mostly spoken of under the botanical name that more properly belongs to the Mediterranean stock. All fuzzy-seeded cottons were often, in fact, regarded as one and the same species. It follows that to secure uniformity and precision in the laboratory and in the experimental farm, the foremost consideration must be the ascertainment of the species botanically that it is intended to investigate. Until such knowledge has been obtained it would be preferable to adopt some arbitrary nomenclature such as a numerical system, *e.g.* the "K2" of geographers, rather than to employ a misleading jargon of botanical names.

Indian Hybrids.

As a historic fact in Indian hybridisation it may be mentioned that in 1844 Mr. Alex. Burns of Broach crossed ***G. obtusifolium***, *var.* ***Wightiana***, with ***G. arboreum***. He obtained a plant that had all the good points of both parents. The leaves were those of ***arboreum***, only larger and more hairy, and the flowers were red with a yellow ring in the throat. This interesting new form, an undoubted hybrid, yielded its crop within a period of two months, much as in Broach *deshi*, and the floss was very silky. The Bombay Chamber of Commerce expressed the opinion that the cross was an exceedingly valuable one. No further information was, however, published regarding it, and the plant seems to have died out. The circumstance is mentioned to show that crosses are possible.

Improvement of Indigenous Stock.

Under the orders of the Government of India much has been recently done to discover the soils suited for cotton generally, and many valuable experiments have been conducted with exotic forms. What would appear the foremost consideration has, however, until very recently been almost entirely neglected, namely the attempt to improve the indigenous or long acclimatised stocks. Royle, for example, repudiated with some warmth the opinion attributed to him, that the greatest attention should be given to the cotton of the country (*Cult. and Comm. of Cotton in India*, 1851, 544–5). For a good few years past I have uniformly urged, and I repeat that recommendation, namely, to make real progress it is imperative that an exhaustive and scientific investigation should be conducted—a sort of census taken—of the existing stocks, not only of India but of the world. The climatic and other causes which tend to preserve or destroy good or bad properties have to be thoroughly established. The influences of hybridisation have to be worked out on a scientific basis by testing the strength of strain, from this species or that, best suited to environment, the tendencies of cultivated forms recognised and systematic renewal of stock in each locality accepted as a solemn obligation.

Effect of Steam Gins.

A few years ago I drew attention to the establishment of steam ginning factories, all over India, as having created a new danger, namely degrading equalisation of stock. Nowadays the cultivators over a wide area carry the produce of their fields to these factories: all are mixed together, and seed returned to the cultivators that in many cases may be utterly unsuited to the fields on which it has to be grown. The specialisation of centuries of natural selection is thus being rapidly effaced by this new phase of commercial production. It has been found useless to urge that the cultivators should reserve their own supplies of seed. They are too poor and too ignorant to do so, and, moreover, are only too frequently in the hands of the money-lenders. (See **Ginning**, pp. 611–2.)

Short Staples.

Lastly another evil has crept gradually into the cotton traffic of India. England having adapted her machinery to the steadily improving staple of the United States, soon became unable to work up the short staples of India. But in Germany, Japan and India itself, special factories were built with the object of running for the lower-class goods and working up the world's supplies of short staple. The cultivators were accordingly told that they would get no more for a long than for a short staple. In every district there were both high-class and low-class staples. The former gave a lower yield, compensated for by a higher price. The new condition naturally dictated the universal substitution of the lower grades, and an agricultural degradation in consequence was carried across the country in a remarkably short space of time that may take a century to efface. An official correspondence dated July, 1903, contains a letter from one of the most influential European merchants of India, which puts the present position tersely by narrating the advantages of the *belati* or *jari* plant of the Central Provinces and Berar :—(*a*) It is an earlier crop, thus enabling the cultivator to get a quicker return ; (*b*) it runs accordingly less risk of injury from early cold weather ; (*c*) it is a hardier plant, less liable to disease or to deterioration from rain ; (*d*) it gives a larger weight outturn of lint ; (*e*) it comes into market cleaner than the other grades.

Advantages of the Present Staple.

Maturity Periods.

Rainfal

Substitution.

The feature of early ripening is most important. The annual cottons of India have often been spoken of as consisting of two kinds—those that take eight months to ripen, and those that reach maturity in about five months from sowing. The cottons found on a deep, moisture-retaining, black, loamy soil are of the first class. They are usually grown as pure crops, and the particular race met with is often remarkably uniform. The cottons of the second class occur on light soils; they are produced normally as mixed crops and manifest the greatest possible variability. The influence of rainfall, both quantity and season, is of vital importance. The vicinity of Bombay town and south of the Konkan, since it possesses double the rainfall of Broach, grows next to no cotton, even although the soil may be highly suitable. Localities, like much of South India, that have two rainy seasons possess two widely different cotton crops. It is very largely in adaptation to the conditions of soil and climate that certain cottons owe their superiority or the opposite. The substitution, for example, of inferior for superior grades has been primarily the result of the demand for that staple, but the change has to many cultivators been all the more acceptable that the plant required was in their locality hardier and less risky. Some twenty to thirty years ago the Central Provinces had a fair proportion of *bani* (superior cotton) relative to its *jari* (or inferior cotton). To-day the crop is mainly *jari*. The former could be spun into yarns of 20's and up even to 40's ; the latter can rarely be used for more than counts up to 10's. The *bani* cottons were the once famed Ghat cottons, such as the Hinganghat of commerce. The *jari* has a very short staple, but is exceedingly hardy and prolific.

Dacca Cotton.

As manifesting the present position of cotton and its degeneration, as also some of the features of the programme of improvement that may be found imperatively necessary, the following jottings regarding the famed Dacca cotton may be usefully set forth :—In view of the efforts presently being made to develop the industry of cotton cultivation in Bengal, it seems desirable that the opinions of the earliest writers be briefly indicated. Mr. Bebb, Commercial Resident of Dacca, furnished a reply to an inquiry made by the East India Company, and that reply is one of the earliest accounts of Dacca (in fact of Bengal) cotton. It is dated 1788, and speaks of the staple as " the finest cotton in the world, producing cloth of astonishing beauty and fineness." The plant is said to have been an annual, and to have afforded two crops in the year, in April and again in September. The first was the most esteemed and obtained the highest price, but was liable to failure from long drought or from violent storms, though moderate showers were highly beneficial. In the volume of Reports on Cotton, Silk and Indigo published by the East India Company in 1836, there is a report written by St. George Tucker in 1829 (*Supply of Cotton from British India*, 159–60) in which he discusses the superior cotton of Dacca. He calls it *bairati kupa*—the finest variety perhaps of the Eastern cottons. It is produced only in small quantity, in the districts north-west of Dacca, and is never exported. Its favourite site seems to be the high banks of the Ganges and its tributaries. The fibre of the *bairati* is extremely fine, silky and strong, but the staple is very short and the wool adheres most tenaciously to the seed. It is admirably calculated for the manufacture of the muslins and thinner fabrics. It is perhaps too costly a production to enter largely into our manufactures. Tucker then adds that the *bogha kupas* is the ordinary cotton staple of Bengal proper.

Dacca Cotton.

Roxburgh, who was appointed Superintendent of the Royal Botanic Gardens of Calcutta in 1793, early gave attention to this special Dacca cotton (Royle, *Cult. and Comm. Cotton*, 245). He gives, in his *Flora Indica*, the points of difference between the ordinary Bengal and the special Dacca cotton. The plant, he says, is more erect, has fewer branches, and the lobes of the leaves more pointed. The whole plant is tinged with red, even the petioles and nerves of the leaves, and it is less pubescent. The peduncles of the flowers are longer and the exterior margins of the petals are tinged with red. The staple is longer, much finer, and softer. Roxburgh's MS. plate of the plant thus distinguished is in the herbarium of the Royal Botanic Gardens, Calcutta (a copy of which is in Kew, and has been reproduced by me in the *Wild and Cultivated Cotton Plants of the World*, pl. 12). It manifests all the special peculiarities mentioned, and thus doubtless faithfully represents the plant; but Roxburgh adds that the people of Dacca think the great difference lies in the spinning and allow little for the influence of the soil. (See remarks on **Hand-loom**, p. 616.)

Muslin Industry.

Differences.

It has recently been affirmed that the cotton formerly used by the Dacca manufacturers, of the far-famed exceedingly fine muslins of that city, was derived from tree cottons. Further, that the loss of those special crops caused the decadence of the muslin industry. Taylor's account (*Topog. and Stat. Dacca*, 1840) would seem to give a complete refutation of that statement. Moreover, the question may be asked, "Is it or is it not a fact that with an exceedingly short staple the Dacca manufacturers are *still* producing (or until very recently were producing) muslins, which if not up to the old standards, are certainly far finer than could be manufactured from these staples by any process or machine known to Europe or America to-day? Taylor says, "The material of which the fine Dacca muslins are made, is entirely the produce of the district. The plant is an annual one, and attains a height of about five feet. It is described by Roxburgh as a variety of the ***G. herbaceum***, and is said to differ from the common cotton plant of Bengal in the following particulars: (1) The branches are more erect and fewer, and the lobes of the leaves more pointed. (2) The whole of the plant is tinged of a reddish colour, even the petioles and nerves of the leaves are less pubescent. (3) The peduncles, which support the flowers, are longer and the exterior margins of the petals are tinged with red. (4) The staple of the cotton is longer, much finer and softer." This is the *desi* or indigenous cotton of the district, which has been cultivated in the northern division from time immemorial.

Selection of Seed.

"Formerly, when this article was more extensively cultivated than at present, there were different shades of quality observable in the staple, which either cannot now be distinguished or have degenerated into one of an inferior degree. They were known by the names of *Phootee, Nurmah* and *Bairaite*. The cotton of the present day, it is affirmed by the Natives, is inferior to what it formerly was. The crops are less abundant; it is said that the fibres, though apparently equally fine and soft, are shorter and more firmly adherent to the seed, than the produce of former years. The Dacca cotton, however, notwithstanding the deterioration imputed to it, still ranks as an article of finer quality than the produce of other parts of Bengal or of the western provinces." . . . "The seeds, which are used for sowing, are carefully picked, and after having been dried in the sun are preserved in an earthen pot in which oil or *ghi* has been kept, and the vessel with its mouth stopped up, so as to exclude the external air, is hung up to the roof of the hut, and over the spot where the fire is usually kindled. The high lands are selected for this crop and are ploughed from eight to twelve times up to September and October when the seeds are sown. This is done in parallel rows, distant about a cubit from each other, and before the seeds are dropped into the ground they are moistened with water. The cotton plant is liable to injury from hail-storms, heavy rain and caterpillars." . . . "Formerly the ground for cotton was allowed to lie fallow every fourth year, and it appeared to be owing to the neglect of this circumstance in the present day, that the produce is now inferior in quality to that of former times."

"The cotton of the northern division is said to swell less than the produce of other parts of the country. This tendency of the fibre to swell in bleaching is the criterion by which the weavers judge of its quality, but whether it depends on any adherent property in the cotton itself, or on the water used in the bleaching is not known, though there is reason to believe that it is principally owing to the latter. The thread manufactured at Dumroy, which was reported by Mr. Bebb, the Commercial Resident, to swell the most, is found by the weavers at present to be equal to the thread of the best *aurungs* or to swell the least if bleached in Dacca, but the reverse, as Mr. Bebb describes it, if the water of Dumroy be used in the process."

Lastly, Sen (*Rept. Agri. Stat. Dacca*, 1889, 52) also says: "The cultivation is not now done half so carefully as was the case at the time of Dr. Taylor. The field is prepared by two to four ploughings and as many harrowings. Furrows are then drawn a cubit apart, and in these furrows cotton seeds previously moistened with dung-water are dropped in thickly. When the plants come out they are thinned to a distance of a foot from one another." (See **Cultivation in Bengal**, p. 607.)

Improvement.

Seed Farms.

Directions of Improvement.

Improvement, when seriously contemplated, will have to be undertaken, not at a great central farm for all India, but district by district. The establishment of seed farms for the supply of specially improved indigenous stock—a subject I had the pleasure of recommending to the consideration of the Scientific Board of Advice at their first meeting—is at present earnestly engaging the attention of the agricultural experts of the Government of India. It may, therefore, suffice by way of concluding this brief sketch of the present position and knowledge regarding the possible methods and results of improvement of cotton stock, to recapitulate the main ideas. Improvement is possible by (*a*) Selection of seed, in adaptation to environment and trade requirements; (*b*) Hybridisation, an additional agency to attain these objects; (*c*) Acclimatisation of prized foreign stocks. All three methods are in India receiving consideration at present. For many of the cotton districts, selection from existing stocks seems the most hopeful method. It may be said, however, that in the discovery of absolutely new stocks, hybridisation is often of special value.

Cotton Expert.

Experiments in Sind.

The Government of India have recently appointed an expert in charge of cotton experiments. The results so far attained in selection and crossing are admittedly of a tentative nature, but Gammie's first report (*Note on the Class. Ind. Cottons and Cross-breeding Exper., Poona Farm*, 1901–2) manifests a useful start as accomplished. The endeavours of the Bombay Government to bring the vast tracts of Sind under Egyptian cotton through the supply of cheap canal water, would seem to have given much promise, and in the public press repeated mention has recently been made of the high prices realised for the cotton already produced. It may thus be confidently affirmed that there does not appear to be any sufficient reason for doubting the success likely to be attained in India than in other countries with the production of superior cottons. The only untoward anticipations centre around the willingness or ability of the Native cultivator to advance with the times. [*Cf.* R. J. Redding, *Essential Steps in Securing an Early Crop of Cotton*, in *U.S. Dept. Agri. Farmer's Bull.*, 1905, No. 217; *Testing Cotton Seed*, in *Agri. Journ. Ind.*, 1906, i., pt. ii., 174; also Sly, *Fumigation American Cotton Seed, etc.*, 1907, ii., pt. ii., 212.]

III. CULTIVATION IN INDIA.

1. *BOMBAY AND SIND.*—Watt, *l.c.* 134–7, 139–54.

D.E.P., iv., 60–84.
Bombay.
Area and Yield.

Area and Production.—According to the official *Agricultural Statistics*, the total area under cotton for 1904–5 in the British districts was 3,605,985 acres. The most important localities were Khandesh, 1,201,673 acres ; Dharwar, 581,950 ; Bijapur, 455,864 ; Ahmedabad, 340,602 ; Broach, 274,699 ; Sind, 218,050 ; Belgaum, 183,207 ; Ahmednagar, 79,626. The area of cotton in the Native States of the Bombay Presidency is an important factor in the Indian cotton supply. This came in 1904-5 to 2,570,985 acres. Kathiawar has usually one to two million acres, and Baroda half a million acres under the crop. The Native States and British districts together thus show the Bombay Presidency with a cotton area of 6,176,970 acres in 1904-5. The yield for the same year was 893,000 bales of 400 lb., or 3,189,285 cwt. The estimated area and yield for the following year were 6,108,900 acres, yielding 1,117,000 bales, in Bombay (including Native States) ; and 265,000 acres, yielding 79,000 bales, in Sind (including Native States), giving totals of 6,373,900 acres and 1,196,000 bales. The *Final Memorandum* for the year 1906-7 gives a total of 3,995,499 acres for the British districts, including Sind, and of 3,462,854 acres for the Native States, a grand total of 7,458,353 acres. This estimate is said to be 49·9 per cent. in excess of the average of the preceding ten years. The estimated yield during the same year is 824,052 bales in the British districts (including Sind), 1,071,243 bales in the Native States. The total is thus 1,895,295 bales, an increase of 132·9 per cent. on the yield of the preceding ten years.

Kathiawar.

Area and Production in 1906-7.

Traffic.—In order to arrive at some tangible conception of the local and foreign interests in the cotton of this Presidency, it may be useful to analyse production and supply in the light of the official returns of trade by rail and river and by sea coastwise, from and into town and Presidency. The most interesting features are the supplies drawn by the town from Kathiawar, from the Presidency of Bombay itself, from Berar and from the Central Provinces. The adjustment arrived at shows the Presidency in 1905-6 to make a net export of 2,765,696 cwt., and assuming this to be drawn exclusively from local production (viz. in 1905-6, 1,117,000 bales or 3,989,285 cwt.), a balance of 1,223,589 cwt. would be the net supply retained by the Presidency. It is not, of course, necessarily the case that all the actual exports of a tract of country are drawn from its own production : an error exists in all such calculations which is eliminated by dealing with the whole of India, and for a number of years, not one year. It is useful, however, to ignore such errors and to analyse the figures as they stand. Accordingly, the port town of Bombay is shown to have imported by (internal transactions) rail and by sea coastwise, 10,583,652 cwt., and to have exported by these routes 261,070 cwt., thus showing a net import of 10,322,582 cwt., and, adding the foreign imports, viz. 158,838 cwt., a total net supply of 10,481,420 cwt. The foreign exports (external transactions) came to 5,289,691 cwt., and thus there remained 5,191,729 cwt. as the supply for the Bombay town mills, or, adding the Presidency surplus (viz. 1,223,589 cwt.), 6,415,318 cwt. are shown as having been available for the Presidency and town of Bombay for the year in question. The town of Karachi imports by rail and river approximately the amount which appears in her foreign exports, viz. in 1905-6, 709,257 cwt. In 1905-6 the total imports by rail and river came to 799,721 cwt., of which the Panjáb supplied 427,485 cwt., Sind almost as much, and the balance came from Rajputana and the United Provinces.

Supply.

Local Consumption.

Bombay Mills.

Sind.

Agricultural Operations.—A full account of the method of cultivation in Bombay is given by Mollison, of which the following may be

Operations.

Seasons.

Manures.

accepted as a summary. The soil of Broach district is deep and retentive of moisture, and over the greater part the annual rainfall exceeds 35 inches on an average. The crop is sown as soon as possible after the monsoon sets in, in June or July, but owing to the effect of the heavy rainfall, two or more sowings may be required before the seeds germinate satisfactorily. Usually the same field grows cotton every second year, and in intermediate years the ground may lie fallow or grow one of the ordinary rotation crops. Manure is rarely applied oftener than once in three years, and fifteen loads per acre is considered a full average. It should be thoroughly decayed and applied preferably before the rains.

Soils.—The crop thrives best on fairly deep black soil, with a rainfall of 30 to 40 inches, and it is grown entirely as a dry crop. The most suitable soil is the so-called "black cotton soil," which may be found in some parts to a depth of five feet or more as in Ahmedabad, Broach and Surat; but cotton also succeeds on much shallower soils.

Associated Crops.

Rotation.—Generally the crop is grown alone, but where the rainfall is heavy and the soil retentive as in Broach, rice in the same or in separate rows is often subordinate to it. ***Coriander***, ***Sesamum***, gram (***Cicer arietinum***) are sometimes sown to fill vacancies. The *rojí* cotton of Kaira, etc., is, on sandy loam soils, always grown as a row crop with *bájra* (***Pennisetum typhoideum***) or pulses. The principal rotation crop with cotton is *juár* (***Sorghum vulgare***), but this may be modified according to district and season. Thus wheat is extensively grown as a dry *rabí* crop on the cotton soils of Ahmedabad, *láng* (***Lathyrus sativus***) and a mixed crop of *tuver* (***Cajanus indicus***) and ***Sesamum*** as *rabí* crops in Broach, etc.

Tillage.

Tillage.—Preparatory tilling begins usually in the hot weather by collecting and burning the stubble of the previous crop. Two ploughings and two more harrowings may be required before the seed is sown, but the amount of preparatory tillage necessary depends on the previous crop.

Seed.

Seed to Acre.

Seed.—The seeds require special preparation for sowing, as they generally cling together, owing to the lint and fuzz which may still adhere to them. This is accomplished by mixing them with a thin plaster of cowdung, mud and water, and rubbing the plastered seed on the close network of a Native bedstead. The seeds can then be passed through the seed-bowls and tubes of an ordinary country seed-drill. If sown alone the seed is drilled in rows 22 to 26 inches apart. About 15 lb. per acre is the usual seed rate. Two harrows follow one drill to cover the seed and smooth the surface. If the seedlings are damaged before they produce true leaves, the crop should be resown, if the season has not too far advanced.

When the seedlings are about 4 inches high, the crop is ordinarily intercultured with the bullock hoe and hand-weeded. The weaklings are then thinned out and the plants left about 18 inches to 2 feet apart, if in good condition, but if backward or stunted they are left closer together. The plough is finally passed between the rows in September or October.

Flowering Season.

Picking.

Crop.—Flowering begins in October–November, and may last till January if the rains are late and favourable. Picking usually commences in January and lasts till March or April. The crop is picked at short intervals, as the cultivators are afraid of their fields being robbed at night. The best time for picking is the morning, as the lint is then clean, owing to the dew on the foliage.

Yield and Cost.—According to Mollison, the average outturn of seed and cotton together in the Presidency varies from about 300 lb. per acre in the Karnátak to as high as 446 lb. in some well-cultivated fields in Broach. The proportion of clean to seed cotton is on an average about one to three. The total cost of cultivation per acre in the Surat district he estimates at Rs. 21-13 annas.

Surat *versus* Broach.

Modifications on above System.—In Surat the average rainfall is slightly heavier than in Broach, but the soil is not so deep nor so dense, and there is less risk of seedlings being destroyed by rain. The rotation crops are mostly *kharíf*, whereas in Broach they are *rabí*. *Juar* is the principal rotation crop, always with a subordinate mixture of white *tuver*. Rice is never sown with cotton in Surat.

Karnátak.

Dharwar.

The principal variation in cultivation in the Karnátak is due to the monsoons—the south-west between June and October, and the north-east between October and December. If sowing were to take place in June, as in other districts, the Dharwar crop would ripen in the middle of the north-east monsoon and the cotton be damaged by rain. To prevent this, sowing usually takes place in the latter part of August, and may be even extended to September. The seedlings are not thinned out to the same extent as in Broach and Surat, but are left comparatively close together.

Khandesh.

In Khandesh two forms of cotton are grown, the one on black and the other on light soil; they generally occupy the same field once in three years. The light-soil crop yields best with heavy rainfall, the black-soil crop with moderate rainfall. The seed rate is 10 to 12 lb. per acre and is sown, if possible, by June. Picking begins in October and is complete in December. In cotton-picking, care should be taken to avoid floss which is discoloured and damaged by boll-worm, as such obtains a poorer price and its presence lowers the average rate obtained.

Seed Selection.

Washing the Seed.

Atmospheric Disturbances.

In selecting seed for next crop, care should be taken to secure bolls from the largest, healthiest and most copiously fruiting plants. Seed should not be taken from plants on which any of the bolls are affected by boll-worm. As a further precaution against boll-worm, cotton seed should, before it is prepared for sowing, be steeped for five minutes in a ½ per cent. solution of copper sulphate and then dried in the sun. Disastrous effects on the cotton crop may be produced by sudden atmospheric disturbances. The most trying consequences are due to heavy rainfall, frequent changes of wind, cloudy weather and frost. An abstract from Mr. Walton's *History of Cotton in Bombay*, detailing the various diseases caused by these conditions, is given in the *Dictionary* (iv., 70).

Egyptian.

Exotic Cottons.—Except in the Karnátak, where an American cotton has been acclimatised, foreign cottons have failed to take any very prominent place. In this connection mention may be made of the attempts of the late Mr. Tata of Bombay to grow Egyptian cotton beyond the Ghats as a *rabi* crop in the eight months of dry weather that prevail between the monsoons. The result may be said to have been a failure. At Poona in 1900 two Egyptian cottons were tried. They had an unhealthy appearance from the first, many of the bolls dropped before they were ripe, and both together gave an average outturn of only 401 lb., lint and seed, per acre.

Irrigation Cotton.

SIND.—Area and Production.—In the *Final Memorandum* for 1906-7

Flooding.

on cotton-growing in India, issued by the Government, the total area in Sind and its Native States was 245,549 acres. The method of cultivation in Sind differs considerably from that pursued in Bombay. The rainfall is excessively small, and the greater part of the cotton is cultivated by irrigation. An unfailing supply of water can be procured from the Indus. Two methods of cultivation are employed. By the first, frequent watering is necessary after sowing, and the seed is sown on ridges in holes 18 inches apart, after the surface has been inundated. By the second, no watering after sowing is required. The only care necessary is to keep the earth about the stems loose and free from weeds.

Seasons.—In Upper Sind the crop is sown at the end of February or beginning of March, or sometimes as late as May or even June. Picking ordinarily takes place in July to August. After picking, cattle are turned on to the fields to graze, but the roots are left for a second year. Farmyard manure is used, about 12 maunds to the *bigha*. In other parts of Sind cotton is not cultivated till the canals fill in June, and the crop consequently is not picked till November or December.

Egyptian.

Exotic Cottons.—Unlike Bombay, the experiments with Egyptian cottons would appear to have been successful. In a report on the experiments carried on at Dhoro Náro, dated August 30, 1904, Mr. F. Fletcher, then Deputy Director of Agriculture, said of *ashmouni* and *abassi* cottons that they yield a minimum of 1,500 lb. of seed-cotton per acre. The plants were irrigated every fifteen or twenty days, at the rate of about 380 cubic metres per acre. In his opinion the experiments so far conducted have sufficiently demonstrated that on perennially irrigated areas in Sind, the Egyptian cottons can be grown normally, and would presumably give even a large yield, but the proper time for sowing would be February or March, and not, as now practised, June to July. He further holds that over-irrigation is often practised on the Jamrás. The report then concludes that if the whole of Sind were put under perennial irrigation (through a dam constructed at Bukker) the potentialities of the province for cotton-growing could not be surpassed even by the United States. Mr. Fletcher's experience in Egypt gives an importance to his utterance on the question of cotton-growing in Sind that carries it to a higher platform than the sanguine expectations of many previous writers on Indian cotton-growing. The area under Egyptian cotton at present is 1,500 acres, but if Mr. Fletcher's expectations are even partially realised the future may witness a greatly increased interest in this subject, much to the advantage of India. [*Cf.* Watt, *l.c.* 225–6.]

High Expectations.

[*Cf.* Royle, *Cult. and Comm. of Cotton in Ind.*, 1851, 332–464; W. R. Cassels, *Cotton in the Bombay Pres.*, 1862; *Ann. Rept. on Cotton, Bomb. Pres.*, 1880–1; *Crop Exper. Bomb. Pres.*, 1890–1900; *Exp. Farm Rept. Poona*, 1893–4, 9–10; 1894–5 14–6; 1895–6, 18–9; 1896–7, 33; *Surat Farm*, 1900–1, 12–5; 1902–3, 33–5; *Exp. Farm Rept., Bomb. Pres.*, 1903–4, 1–13; Middleton, *Agri. Ledg.*, 1895, No. 8, 95–100; *Cottons of Southern Maratha Country*, 7; *Sind and Persian Cottons*, 17–8; *Text. Journ.*, Oct. 1897, 1; May, 1901, 215–6; Mollison, *Textbook Ind. Agri.*, 1901, iii. 215–24; *Pioneer Mail*, Feb. 1, 1901, 8; *Times of Ind.*, Nov. 9, 1904; Sly, *Egyptian Cotton in Sind*, in *Agri. Journ. Ind.*, April 1906, i., pt. ii., 165–8; Fletcher, *Improv. of Cottons in Bombay Pres.*, in *Agri. Journ. Ind.*, 1906, i., pt. iv., 351–89.]

D.E.P., iv., 86–96, 128–32. C.Prov. and Berar.

2. ***CENTRAL PROVINCES AND BERAR.***—Watt, *l.c.* 131–4.—***Area and Production.***—On an average of the five years ending 1904–5 the tract under cotton represented 23·60 per cent. of the total cotton area in British India. In 1904–5 there were 1,492,323 acres in the Central

Provinces and 3,069,024 acres in Berar. The comparative importance of the various districts may be gathered from the returns for the year named : CENTRAL PROVINCES—Wardha, 404,405 acres ; Nagpur, 404,411 ; Nimar, 298,387 ; Chhindwara, 113,780 ; BERAR—Amráoti, 715,127 ; Akola, 743,268 ; Wun, 478,211 ; Buldána, 421,768 ; Básim, 362,059 ; and Ellichpur, 348,591. The yield for the same year was 472,000 bales, or 1,692,857 cwt., in the Central Provinces ; 755,000 bales, or 2,696,428 cwt., in Berar. The estimated area and yield for the year following were 1,586,000 acres and 347,000 bales in the Central Provinces ; 3,197,900 acres and 483,000 bales in Berar ; giving totals of 4,783,900 acres and 830,000 bales. The final forecast for 1906-7 shows the total area for both the Central Provinces and Berar at 4,852,087 acres, or an increase of 45 per cent. on the decennial average. The yield for the same year is estimated at 880,984 bales, an increase of about 8 per cent. on the previous year.

Area and Production in 1906-7.

Internal Trade.

Traffic.—Since 1903-4 the figures of railborne traffic have been returned for the Central Provinces and Berar conjointly, consequently 1903-4 is the last year in which they can be discussed separately. The Berar railborne traffic in 1903-4 shows a large export and insignificant import. The net exports in 1903-4 came to 2,049,881 cwt., by far the major portion going to the town of Bombay, the balance to Bengal Province (practically none to Calcutta), Bombay Presidency and the Central Provinces. A fairly large amount is usually shown exported in excess of local production, indicating possibly a considerable traffic by road that escapes registration. In the Central Provinces the net export amounted in 1903-4 to only 846,957 cwt., as compared with 2,049,881 cwt. in Berar. The difference is due chiefly to the large quantity the Central Provinces import, viz. 143,822 cwt. in 1903-4, far the largest part of which comes from Berar, Rajputana and Central India. Almost the whole of the exports go to the town of Bombay, an insignificant surplus going to the Presidency of Bombay and to Bengal. In 1905-6 the net exports from the Central Provinces and Berar together amounted to 4,229,617 cwt.

Associated Crops.

Agricultural Operations.—Rotation.—In Berar, *tur* (*Cajanus indicus*), in the proportion of one-tenth, is generally associated with the cotton crop, but in the villages to the south and above the Ghats, *bajra* (*Pennisetum typhoideum*) and *til* (*Sesamum indicum*) sometimes replace it. Rotation is regarded as absolutely necessary. On light soils, cotton is usually rotated with *juar* only (*Sorghum vulgare*), but on the rich black soils of the plains, cotton, *juar* and a *rabí* crop are rotated alternately. A plurality of crops is generally grown in the third year, separate parts of the field being devoted to wheat, gram, linseed, or *lakh* (*Lathyrus sativus*), and these in their turn are also rotated. Preparatory ploughing is not carried out every year, as it is considered to impoverish the soil, unless manure be subsequently applied. The advantages of manure are thoroughly understood by the cultivators, but there is great difficulty in Berar in obtaining a supply. Poudrette is considered best, and cowdung comes next in order. Green soiling is sometimes, but very rarely, resorted to. Ploughing generally takes place in December or January, as soon as the crop of the year is removed. The fields are always cross-ploughed. Harrowing succeeds ploughing, and in the case of unploughed fields is the only preparatory operation.

Manures.

Ploughing.

Seed.—Sowing commences with the first fall of rain, in the early part of June. The seed of the previous year's crop is always used, and is prepared and sown much as in Bombay. Ten pounds of seed are considered sufficient for an acre of land. Should a period of drought occur after sowing, the seed will be destroyed, or if rainfall be excessive it may rot. In both cases the crop must be resown. From 20 to 25 inches of rain are enough provided it falls at timely intervals. Under favourable conditions the young plant will put forth four or five leaves in a fortnight, and weeding then becomes necessary. Between the rows, this is done by the bullock hoe, but on the rows, the weeds are removed by hand. Bullock hoeing is carried on at intervals of a fortnight till the pods appear.

Rainfall.

Crop.—The bolls ripen and open in October, and the cotton is then ready for picking. The first generally takes place at the end of October or beginning of November. If the crop is a good one, three to seven pickings can be made, according to the kind of cotton grown. The total cost of cultivation has been estimated at about Rs. 13 to Rs. 15 per acre.

Picking.

Cost.

In the Central Provinces the method of cultivation does not differ materially from that in Berar. The soil is prepared for sowing in May to June; the seed is sown in June; picking commences in November to December, and is completed from Frebruary to March.

Seasons.

[*Cf.* Medlicott, *Cotton Handbook for Bengal,* 1862, 254–84; Cassels, *l.c.* 194–227; *Ann. Rept. Ind. Mus.* (Indust. Sec.), 1894–5, 23–4; Fuller, *Note on Outturn of Land under Principal Crops, Cent. Prov.*, 1894, 26–30; Middleton, *l.c.*, *Cottons of Cent. Prov, Berar and Khandesh,* 12–3; F. W. Francis, *Cot. Cult. in Berar.* (ser. H.A.D.), 1898, No. 2; R. S. Joshi, *Exper. Cult. of Egypt. Cotton at Nagpur, Dept. Land Rec. and Agri. Cent. Prov., Bull.* 1901, No. 3; *Exper. Farm Repts. Nagpur,* 1890–1904; Gaskin, *Cotton Cult. and Trade in Cent. Prov. and Berar,* in *Agri. Journ Ind.*, April 1907, ii., pt. ii., 171–92.]

Having devoted so much space to the chief cotton-producing areas of India, an effort may now be made to abbreviate as far as possible the accounts that follow of the other provinces to the particulars of chief importance:—

D.E.P., iv., 132–3.
Nizam's Dominions

NIZAM'S DOMINIONS.*—*Area and Production.—The authoritative figures for 1903–4, show the area to have been 2,660,713 acres and the yield 982,867 cwt., or 275,203 bales. The largest cotton area is the Aurangabad Division, which in 1903–4 grew 1,464,116 acres. Then follow Gulbarga, 874,032 acres; Bidar, 232,096 acres; and Warangal, 75,161 acres. The forecast for 1905–6 reported an area of 2,537,000 acres and a yield of 206,000 bales, or 735,714 cwt.

The trade returns for 1905–6 show that the net export was 801,144 cwt., or 65,430 cwt. in excess of the estimated outturn. The exports went chiefly to the town and Presidency of Bombay, and a considerable quantity to the Madras ports.

D.E.P., iv., 96–9.
Rajputana and Central India.

3. ***RAJPUTANA AND CENTRAL INDIA.*—*Area and Production.***—The area for 1901–5 was 469,000 acres in Rajputana and 846,000 acres in Central India, a total of 1,315,000 acres. The yield for the same year was 1,150,000 cwt., or 322,000 bales. The estimated area and yield for the following year were 289,000 acres and 61,000 bales in Rajputana; 968,000 acres and 129,000 bales in Central India. The latest statistics (1906–7) estimate an area of 428,000 acres in Rajputana; 1,117,000 acres in Central India; with a yield in bales of 176,000 in Rajputana; 291,000 in Central India, giving totals of 1,515,000 acres and 467,000 bales.

The net export trade of Rajputana and Central India amounted in 1905–6 to 856,934 cwt., and as the estimated outturn in that year was 190,000 bales, or 678,571 cwt., the exports for the year were considerably in excess of the outturn. The largest share of the exports go to the town of Bombay, the United Provinces and the Presidency of Bombay. The Central Provinces, the Panjáb, and the towns of Calcutta and Karachi also receive considerable quantities. The imports come chiefly from Bengal, the United Provinces, the Central Provinces and Berar.

AGRICULTURAL OPERATIONS.—Rotation.—The soils are fertile though light. They fall under Middleton's third class, which yields the Bengals of commerce. The plant is grown as a mixed crop, usually with *til*, *arhár* (***Cajanus indicus***) and *san* (***Crotalaria juncea***), etc. The ground is prepared by ploughing and manuring. The seed is then sown broadcast in the month of April or June, and the land immediately after is lightly ploughed and later on again ploughed. Picking commences in October and is completed by the end of the year. The cost of cultivation has been estimated at Rs. 25 per acre. [*Cf.* J. Forbes Royle, *l.c.* 309–29; Medlicott, *l.c.* 1862, 243–53; Middleton, *Rajputana Cotton*, *l.c.* 16.]

Manures.
Sowings.
Seasons.
Cost.

4. ***MADRAS.***—Watt, *l.c.* 128–31, 151.—***Area and Production.***—Madras ordinarily grows about 14 per cent. of the cotton crop of British India, or 9·2 per cent. of the entire cotton area. In 1904–5 the total was 2,007,297 acres. The principal districts are usually the following (the figures denoting the acreages in 1904–5):—Bellary, 408,388; Karnul, 268,067; Tinnevelly, 250,521; Coimbatore, 256,948; Guntur, 210,487; Anantapur, 171,051; Cuddapah, 127,854. The yield for the same year was 132,000 bales, or 471,428 cwt. The estimated area and yield for the following year were 1,634,000 acres and 148,000 bales (528,571 cwt.). The latest available figures for the year ending December 1906 show an estimated area (*raiyatwari*) of 1,544,000 acres, with a yield for the same period of 151,000 bales.

D.E.P.,
iv., 99–108.
Madras.

Traffic.—The most noteworthy point regarding the trade of Madras in 1905–6 is the fact that the exports from the Presidency exceeded the outturn. The net export was 864,947 cwt., or 336,376 cwt. in excess of the outturn, which was drawn from beyond the Presidency. The Madras ports had a net import by rail of 932,336 cwt., and by sea coastwise of 10,195 cwt., thus giving a total import of 942,531 cwt. The foreign exports came to 800,479 cwt., and this left 142,052 cwt. as the supply of the Madras town mills.

AGRICULTURAL OPERATIONS.—Forms of Plant.—There are two forms of indigenous cotton usually grown in Madras, one depending on the south-west monsoon, the other on the north-east. The former is sown between May and July, the latter, between September and November. In Tinnevelly both are sown in the same season, October to November. In the Tamil districts these crops are known as *uppam* and *nadam*. The *uppam* crop is generally sown on black cotton soil, the *nadam* on red or gravelly soils. These produce the four commercial forms known as Tinnevellys, Westerns, Coconadas and Salems. Manure is seldom added, but cowdung or wood-ashes may sometimes be lightly scattered over the ground; and if cattle are not permitted to browse on the fields, the leaves and twigs of the previous year often remain, and thus very possibly carry disease from one crop to another. Irrigation is seldom resorted to, and the *raiyat* has to depend for the successful growth of his crops on the periodical rains.

Two Crops.
Seasons.
Manure.
Irrigation.

Rotation.—In exceptional cases cotton is grown continuously, but the general practice is to have a rotation. The principal rotation crops are *kambú* (***Pennisetum typhoideum***) and *varágu* (***Panicum miliaceum***), sometimes also *cholam* (***Sorghum vulgare***) and horse or Bengal gram. If the land is clean, three ploughings before sowing are ordinarily sufficient, but more may be necessary. The soil is ploughed in a drier condition than for grain crops.

Associated Crops.
Ploughing.

Seed.—The seed, which has to be prepared as in other provinces, is generally sown broadcast, and as a rule the same stock is sown over and over again. The seed rate is about 10 lb. per acre. In some districts, however, it is drill-sown in parallel lines, alternately with pulse. The seedlings appear between the third and seventh day. When they are three weeks old the plantation is hand-weeded, and the process repeated several times during growth. The plants begin to flower about the fourth and to ripen their fruit about the sixth month of their growth. In some cases this does not take place till the eighth month. In Tinnevelly, however, the first blooms appear in the third month after sowing and the first bolls open in the fourth month.

Weeding.
Seasons.

Crop.—The pods, as a rule, are not collected as they ripen, but are allowed to remain until the whole crop of the field is ready. The time of harvesting varies, according to the district and time of sowing, from January to August. The cotton crop in Madras seems to be specially liable to the attacks of numerous insects and fungal parasites. An ordinary crop of cotton (in form of seed-cotton) in Tinnevelly runs from 750 to 900 lb. per acre, while 500 lb. is stated to be a fair average when all sorts of soil are taken into consideration. The cost of cultivation varies considerably in different districts. In Anantapur it has been estimated at Rs. 2-13-2 per acre; in South Canara at Rs. 14 per acre. [*Cf.* Buchanan-Hamilton, *Journ. through Mysore, etc.*, 1807, ii., 157–8, 221–3, 254, 313–4, 326–7, 450–1, 545; Royle, *l.c.* 464–537; Cassels, *l.c.* 262–3; J. Talboys Wheeler, *Handbook on Cotton Cult. in Madras Pres.*, 1862; Gribble, *Man. of Cuddapah Dist.*, 1875, 201–4; Nicholson, *Man of Coimbatore*, 1887, 232–5; *Cotton in Madras Pres., Agri. Dept. Mad., Bull.* 1890, No. 9; S. Iyer, *Rept. on Growth of Cotton in Tinnevelly, Agri. Dept. Mad., Bull.* 1891, No. 19; Middleton, *l.c.* 7–9; *Rept. on Operations Agri. Dept. Mad.*, 1903–4, 5; *Madras Weekly Mail*, Sept. 8, 1904, 248; Nov. 24, 1904; *Proc. Agri.-Hort. Soc. Mad.*, April–June 1905, 28–31, 36–7.]

Insect Pests.
Cost.

D.E.P.,
iv., 147–8.
Mysore.

MYSORE AND COORG.—Area and Production.—The area under cotton in 1904–5 was 71,000 acres and the yield 17,857 cwt., or 5,000 bales; in 1905–6, 76,000 acres with the same yield. The principal districts are Chitaldrug, Tumkur, Mysore and Shimoga. The final estimate for 1906–7 shows a total of 89,000 acres and a yield of 10,000 bales. In 1905–6 Mysore had a net export of 40,287 cwt., or 22,430 cwt. in excess of the estimated outturn. Almost all went to Bombay Province, while small quantities found their way to the Province of Madras, the Madras ports and the town of Bombay. The imports came from the Provinces of Bombay, Madras, and the town of Bombay.

Pruning Cotton.

Cotton is not an important crop, and there is little of an exceptional character to be recorded regarding either the plant grown or the methods of cultivation pursued, except that after giving a crop the plants are cut down close to the ground, and in a month after the succeeding rainy season they produce a second crop about twice as large as the first. This appears to be one of the few records in modern times of the pruning of cotton. Hove records, however, that in Gujarat the red-flowered plant was regularly pruned during his time (1787). The older writers on cotton frequently allude to the practice prevailing in the West Indies. [*Cf.* Watt, *l.c.* 94, 259, 286, 309, 322.] It is curious that it should have survived in Mysore, a country closely connected with one of the once famed red-flowered cottons. [*Cf.* Buchanan-Hamilton, *l.c.* 1807, i., 40, 203, 378–9, 411; iii., 323–4, 351; Lewis Rice, *Mysore Gaz.*, 1897, i., 125–6.]

D.E.P.,
iv., 117–28.
Panjáb.

5. ***PANJÁB. Area and Production.***—On an average of the five years ending 1904–5 the area under cotton in the Panjáb represented about 7·3 per cent. of the total area under cotton in British India. For 1903–4 the Panjáb area, including the North-West Frontier and Native States, was 1,747,000 acres and the yield 1,492,857 cwt., or 418,000 bales. The estimated area for the following year (1905–6) was 2,017,000 acres and the yield 205,000 bales, or 732,142 cwt. The final forecast for 1906–7 gives the area as 1,408,000 acres in the Panjáb and 61,000 acres in the North-West Frontier, a total of 1,469,000 acres and yield of 370,000 bales. The most extensive areas returned for 1904–5 were:—Lyallpur, 165,849, acres; Lahore, 142,621; Hissar, 96,862; Rohtak, 95,880; Gurgaon 92,859; Karnál, 75,008; Multan, 70,342; Gujránwála, 53,488; Sháhpur, 31,155; and Montgomery, 37,474. In the North-West Frontier, Peshawar, 19,658 acres.

Area and
Production
1906–7.

Traffic.—The net exports from the Panjáb in 1905–6 amounted to

568,307 cwt. As the outturn in the same year was 732,142 cwt., it thus exceeded the net export by 163,835 cwt. The largest quantity goes to the port town of Karachi, while considerable quantities also are consigned to the towns of Bombay and Calcutta. The imports come chiefly from the United Provinces. Delhi is the most important manufacturing centre in the province.

Soils.
Manure.
Irrigation.
Rotation.

Soils, Manures, etc.—The soil of the Panjáb is generally well suited to the cultivation of cotton, if irrigated or subject to inundation. All kinds of productive soils appear equally well adapted. Manure is frequently applied, and irrigation either by canals or wells is the general rule. In some of the eastern districts cotton is raised as an unirrigated crop, but nearly always in positions where the young plants can, if necessary, be watered from a neighbouring tank. The crop is generally mixed with others, of which the commonest are *til*, melons and pulses. Throughout the eastern districts it is the usual practice to sow ***Hibiscus cannabinus*** in strips along the edge of the cotton fields, or in alternate rows with the crop. In the Central Panjáb certain leguminous crops (species of ***Melilotus***, ***Trigonella***, etc.) are commonly sown with the cotton, as an after crop to be used as fodder for well-bullocks.

Seed.
Crop.
Cost.

Seasons, Crop, etc.—The period of sowing varies in different parts of the province and is largely influenced by the rainfall and the race of plant grown, as also the altitude of locality. In Gurgaon from March to May it is sown near wells, or where there are other means of irrigation, and in June to July on rain lands as soon as the first showers break. In Shahpur and other districts sowings generally go on from the middle of February to the end of March, and in well-watered lands to April or May. The seed is sown broadcast at about the rate of 8 to 12 seers to the acre. The crop requires to be weeded and watered several times during growth. Picking takes place about November and December. The pods do not all ripen at once, and it is necessary to go over the field several times. Picking ought to be completed before January owing to the danger of loss from frost. It is difficult to give a precise statement as to the cost of cultivation. It differs considerably in some districts, and largely depends on the method of irrigation and the use or not of manure. On land both irrigated and manured, the highest figures quoted are in Jalandhar, Rs. 37-13-4 per acre; the lowest in Jhang, Rs. 10-0-9 per acre. [*Cf.* Royle, *l.c.* 301-9; Medlicott, *l.c.* 218-28, 233-42; Stewart, *Pb. Pl.*, 1869, 22; *Dist. Gaz. Pb.*, 1890-1902; *Settl. Rept. Jallandar*, 1892, 123-4; Middleton, *l.c.* 14-5.]

Kashmir.

Kashmir.—Lawrence (*Valley of Kashmir*, 1895, 340-1) gives the following account of cotton. It is found all over Kashmir up to certain elevations. Never less than three ploughings are given before sowing, and the clods are also pulverised by mallets. The seeds are soaked in water and mixed with ashes, but beyond this the plant receives no manure. Sowing takes place at the end of April and in May, and about 48 seers of seed are sown to the acre. It is cultivated only for home consumption. The outturn is generally stated to be about two maunds (164 lb.) per acre.

D.E.P., iv., 109-17.
Agra and Oudh.

6. ***UNITED PROVINCES.—Area and Production.***—On an average of the five years ending 1904-5, the cotton crop in these Provinces represents about 6·6 per cent. of the total cotton area in British India. In 1904-5 the area, including Native States within provincial boundaries, was 1,201,000 acres. In Agra, the districts of Aligarh, 152,407 acres; Muttra, 146,981; Agra, 118,591; Bulandshahr, 109,570; Meerut, 76,866; Etáwah, 61,090; Hamérpur, 52,629; Cawnpore, 52,363; and Bánda, 43,591. In Oudh, the districts of Hardoi, 11,816; Unao, 10,776; and Lucknow, 2,579. The yield for the same year was 1,314,285 cwt., or 368,000 bales. For 1905-6 the total area for the Provinces was 1,372,000 acres and the outturn 394,000 bales, or 1,407,142 cwt., while the final estimate for 1906-7 gives an area of 1,489,000 acres and a yield of 638,000 bales. In connection with this subject an interesting article by Moreland,

Area and Production in 1906-7.

(*Agri. Journ. Ind.*, 1906, i., pt. i., 37-43) on the conditions determining the area sown with cotton in the United Provinces should be consulted.

Traffic.—The net export trade of the United Provinces amounted in 1905-6 to 1,497,159 cwt., or 90,012 cwt. in excess of the outturn. The exports went chiefly to the ports of Bombay and Calcutta and to the Panjáb, small quantities also going to Bengal, Rajputana and Central India. The imports largely came from the Panjáb, Rajputana and Central India, while smaller quantities also came from the Central Provinces, Berar and the port of Bombay. The chief manufacturing centre is Cawnpore.

Uncertain Position.

Low Yield.

Rotation.

Yield.

Cost.

Soils, Rotation, etc.—The best grade of cotton soils in the Provinces are rich loams, which are either directly manured or reap some benefit from manure applied to a previous crop. Cotton is also grown on poor soils such as the calcareous tracts in the neighbourhood of the great rivers. At present cotton appears to have no definite place in the systems of cropping in vogue, which is said to be partly due to the uncertain distribution of rainfall and the consequent uncertain nature of the crop, partly to the low yield and the narrow margin of profit usually secured. Subbiah (*Cult. of Longer-stapled Cottons at Cawnpore Exper. Station*, 1901, 28) suggests various rotations which those interested should consult. On the better classes of soil the crop is generally grown alone, except where rows of *arhar* are sown at intervals of 5 to 7 yards, but on poor ground it is almost invariably associated with four or five subordinate crops, of which *arhar* and *til* are the chief. Subbiah recommends particularly in the cultivation of longer-stapled cottons on irrigable lands, a mixture of cotton and maize in alternate rows at a distance of 1½ to 2 feet. The seed is sown broadcast generally about the middle of June and then ploughed in. The seed rate is about 4 to 6 seers per acre. Irrigation is applied only to about one field in seven. Picking commences about the beginning of October and is in progress from then till the end of January if not cut short by frost. If the plants are allowed to remain after January and are watered and hoed two or three times, a second gathering even better in quantity and quality may be obtained in May and June. On the richer classes of irrigated land Subbiah gives 140 to 230 lb. of clean fibre as an average outturn per acre for the rainy-weather crop, and about as much for the hot-weather crop, giving a total of 280 to 460 lb. of fibre. The cost of cultivation per acre as estimated by Duthie and Fuller amounts to Rs. 22–9, but by Subbiah at the Cawnpore Station from Rs. 61 to Rs. 73.

Exotic Cottons.

Exotic Cottons.—Subbiah's report deals mainly with the efforts made at the Cawnpore Experimental Farm to grow long-stapled American and Egyptian cottons. As a rule the American cottons did better than the Egyptian, since it was found the growing season was too short to allow the latter coming to maturity. It is, therefore, laid down that in introducing long-stapled cottons, it is essential that those be chosen which mature in their native habitat in about the same time that the local country cotton does. [*Cf.* Royle, *Cult. and Comm. Cotton in Ind.*, 1851, 262-301; Medlicott, *l.c.* 165–218, 229-32; *Exper. Farm Repts. Cawnpore*, 1890–1904; Middleton, *l.c. Cottons of United Prov.*, 15–6; Subbiah, *Cotton Acclim. at Cawnpore*, in *Pioneer Mail*, March 17, 1899, 27; *Rept. Govt. Bot. Gard. Saharanpur*, 1904, 3–4.]

D.E.P., iv., 133-9. Bengal.

Area and Production in 1906-7.

7. ***BENGAL.—Area and Production.***—In the province of Bengal as now understood, the area under cotton represents only about 0·6 per cent. of the total area in India. In 1904–5 the estimated area and yield were 78,000 acres and 20,000 bales (71,428 cwt.); in 1905–6, 73,000 acres and 17,000 bales (60,714 cwt.); while the most recent estimate for 1906–7 forecasts the area at 76,477 acres (39,947 acres early cotton and 35,530 late) and the yield 16,030 bales (6,250 early and 9,780 late), or 57,250 cwt. The districts with largest areas are:—Saran, 14,400 acres; Sambalpur, 11,693; Santal Parganas, 10,700; Singhbhum, 7,000; Manbhum, 5,100; Darbhanga, 3,792; Cuttack, 3,400; Muzaffarpur, 3,000, etc.

Traffic.—The trade returns for 1905–6 show that the Province of Bengal, exclusive of Calcutta, made a net import of 86,224 cwt. The outturn for the same year was 60,714 cwt., so the total amount available for local purposes was 146,938 cwt. The town of Calcutta imported by rail and river and by sea (coastwise) 1,063,601 cwt. and exported 90,596, giving a net import of 973,005. By adding the foreign imports (2,331 cwt.) we get a total net import of 975,336 cwt. The foreign exports for the same year were 498,567 cwt., so that the amount available for the Calcutta mills was 474,769 cwt. Including the supply for the province (146,938 cwt.), a total of 645,505 cwt. met the local consumption.

Local Consumption.

Two Crops.

Crops, Seasons, etc.—There are generally speaking two cotton crops in Bengal, the early, sown during the monsoon rains and harvested during the cold weather, and the late, sown at the close of the rainy season and harvested during the hot weather. Early cotton is grown chiefly in the Santal Parganas, Sambalpur, Manbhum, Singhbhum and Angul; late cotton in Saran, Muzaffarpur and Darbhanga.

Bihar Cotton.

It is not deemed necessary to detail the methods of cultivation or other such particulars, since the crop is hardly of sufficient value. In Saran (the largest cotton-growing district of Bengal) cotton is sown as a secondary crop, the seed being sown broadcasted. The so-called *bhadoi* cotton of Saran is sown in January and February and reaped in August; the *bysakhi* sown in June and July and harvested in April. Maxwell-Lefroy (*Notes on Cotton in Bihar, Bull. Agri. Res. Instit., Pusa,* Feb. 1904) mentions three ways by which cotton cultivation might be improved—by drainage, growing with other crops, and sowing at another time of year. He considers the failure of cotton in Bihar as due largely to its inability to withstand the wet season, and the improvements he suggests have as their main object the lessening of the effects of the wet weather. He advises sowing in August to October instead of June as the young plants would not then have to struggle through the long rainy season, and the insect pests, which are worst in June, July and August, would not affect the crop seriously. In a note drawn up at the request of the Lieutenant-Governor of Bengal, Mollison (*Ind. Pl. Gaz.,* March 12, 1904, 345) gives an account of recent experiments in Bihar, which the reader should consult; also the efforts made by Messrs. Shaw, Wallace & Co. of Calcutta to grow tree cottons in various parts of the province. Particulars of these latter experiments have been given by Sly (*Proc. Govt. Ind. Dept. Rev. and Agri.,* March 1905.) [*Cf.* Royle, *Cult. and Comm. of Cotton in India,* 1851, 241–62; Grant, *Rural Life in Bengal,* 1860, 187–8; Hunter, *Stat. Acc. Beng.,* 1877, xvi., 105, 342–3; Sen, *Rept. Agri. Stat. Dacca,* 1889, 51–2; Basu, *Agri. Lohardaga,* 1890, pt. i., 71–3; ii., 35–7; Banerjei, *Agri. Cuttack,* 1893, 86–8; Middleton, *l.c.* 9–12; Banerjei, *Monog. on Cotton Fabrics Beng.,* 1898; Mukerji, *Handbook Ind. Agri.,* 1903; *Natural Fert. available for Cotton in Ind., Dept. Rev. and Agri. Proc.,* May 1904; *Ind. Pl. and Gard.,* Dec. 3, 1904; Feb. 18, 1905, 118–9; *Capital,* Jan. 14, 1904, 50.]

Change in Seasons.

Tree Cotton.

D.E.P., iv., 139–46. E. Bengal and Assam.

8. ***EASTERN BENGAL AND ASSAM.—Area and Production.***—The area under cotton represents some 0·3 per cent. of the total under cotton in British India. In 1904–5 it was estimated at 50,000 acres and the yield 17,000 bales (60,714 cwt.); in 1905–6 at 61,000 acres with the same yield; while the latest forecast, namely for 1906–7, puts the area at 57,333 acres and the yield at 13,680 bales (48,857 cwt.). The Chittagong hill tracts are there shown to have an area of 26,636 acres; Garo hills, 23,000; Nowgong, 3,400; Sylhet, 2,060; Khasia and Jaintia hills, 1,000; while smaller areas are recorded in Cachar, Sibsagar, Goalpara, Jalpaiguri and Kamrup.

[*Cf.* Montgomery Martin, *Hist. Antiq., etc., E. Ind.,* 1838, iii., 665, 671, 686–8, 694; Hunter, *Stat. Acc. Assam,* 1879, i., 252; ii., 151, 191, 225–6, 288; Middleton, *Assam Cottons, l.c.* 18–20; *Ann. Rept. Dept. Land Rec. and Agri. Assam,* 1901–3, 22; *Capital,* May 19, 1904.]

D.E.P., iv., 148–52. Burma.

9. ***BURMA.—Area and Production.***—Burma produces about 0·9 per cent. of the total cotton crop of British India. The area for 1904–5 was estimated at 189,000 acres and the yield 139,285 cwt., or 39,000 bales.

The relative importance of the chief localities in Upper Burma may be expressed by the returns of the year named :—Myingyan, 65,511 acres ; Sagaing, 49,575 ; Meiktila, 36,161 ; Lower Chindwin, 13,672 ; and in Lower Burma, Thayetmyo (Lower Burma portion), 12,275. In the following year (1905–6) the estimated area and outturn were 183,000 acres and the yield 35,000 bales (125,000 cwt.) ; while for 1906–7 the estimates were 186,000 acres, with the same yield.

Area and Production in 1906-7.

Traffic.—The trade returns for 1905–6 show that Burma had a net export of 39,225 cwt. The outturn for the same year was 125,000 cwt., so the net supply available for local consumption was 85,775 cwt. Almost all the exports went to Calcutta, but small quantities were also sent to Bombay port and to Pondicherry.

Soils.

Crops, Seasons, etc.—The most suitable areas for cotton are found in the dry zone of Upper Burma. It is there cultivated on good and medium black cotton soil but is also found on inferior soils of a lighter colour. Burkill (in a *Report on Cotton in Burma* dated March 25, 1904) states that cotton is grown on *kain* land (land periodically flooded by rivers), on *taung yas* (forest clearings), and on *ya* (high, dry land). On *kain* land the seed is sown in September after the floods have left the ground, but such cultivation is now rare. On forest clearings cotton is also said to be unimportant, as the land is more serviceable for other crops. The most important, therefore, is the third, viz. cotton grown on high, dry land.

Races of Plant.

Two kinds of cotton are in general cultivation, the annual (*wa-gale*), which is sown in April and May and yields from October to December, and a perennial, (*wa-gyi*) which is sown at the same season as the annual but continues on the fields for three years and yields annually in February or March. The annual is most extensively grown. *Wa-gyi* is a common crop in Minbu and Thayetmyo, but rare elsewhere. Manuring is general, farmyard manure being considered best.

Yield.

The yield per acre of seed-cotton Burkill gives as follows :—on first-class soil, 73 viss (viss = 3·65 lb.) ; second-class soil, 42 viss ; third-class soil, 32 viss. In 1901–2 the average yield per acre of clean cotton for the whole province was only 80 lb. ; according to the figures discussed in the *Dictionary* (taken from reports by the Deputy Commissioner of Meiktila), the yield would appear to average from 125 to 250 viss an acre of seed-cotton. [*Cf.* Browne, *Stat. and Hist. Acc. Thayetmyo*, 1873, 87–8 ; *Rept. on Settl. Oper. Meiktila Dist.*, 1896–8, 7–8 ; Arnold, *Monog. on Cotton Fabrics and Cotton Indust. Burma*, 1897, 16–8 ; *Upper Burma Gaz.*, 1900, ii., pt. 1, 363 ; *Rept. on Settl. Oper. Myingyan*, 1899–1901, 32, 42 ; Mollison, *Rept. on Cotton Cult. in Burma*, Aug. 18, 1904 ; *Rangoon Times*, July 3, 1903 ; Sly, *Cotton Cult. in Burma*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 253–4.]

Cotton Soils.

IV. SOILS AND MANURES.—As already mentioned, Middleton (*Agri. Ledg.*, 1895, No. 8, 117) classifies the Indian cotton soils into three well-marked sections :—(1) rich black clay soils, such as those of Surat and Broach, which produce the finest cottons ; (2) soils like those of Kathiawar, Khandesh, Berar and the Central Provinces, that produce the second-grade cottons ; and (3) a very large area, too sandy or with too small a rainfall to ripen the finer cottons—the source of the Bengals of commerce. Bombay Presidency has soils and climates of all three grades, but it is much more favourably placed than other provinces, by having a larger proportion of both the first and second grade soils.

Indo-Gangetic Alluvium.

In his paper on Indian soils, Leather (*Agri. Ledg.*, 1898, No. 2) makes four main heads :—the Indo-Gangetic alluvium ; black cotton or *regur* ; red soils lying on metamorphic formations (in Madras) ; and laterite soils. The first consists generally of a yellow-coloured alluvium, sometimes sandy, sometimes stiff clay. The only rocky particles larger than sand which this expanse of land contains is the nodular limestone, *kankar*. (For theory of formation, see p. 711.) Leather states that in the samples he examined, the amount of phosphoric acid, though small, was more than in other Indian soils. The commonest form of red soil is a sandy clay coloured by iron peroxide. It may be derived from the rocks *in situ* or from the same products of decomposition washed by rain to lower levels. Laterite soils are simply soils lying on or adjacent to laterite rocks. The composition of both these classes, according to Leather's analyses, varies considerably, but, like other soils of India, both are deficient in phosphoric acid and nitrogen.

Regur Soils.

It is on the black cotton or *regur* soils that Indian cottons are generally grown. Typical *regur* areas are well represented in the Bombay and Madras Presidencies. The condition indicated may be described as a highly argillaceous, calcareous clay, very adhesive when wet, and from its absorbent nature expanding and again contracting to a remarkable extent. In consequence, during the hot weather, such soils become fissured in every direction by huge cracks, which in depth vary greatly. In some parts, for example at Akola, they have been reported as seen from 40 to 60 feet deep. Underlying the *regur* is a bed of yellow-white earth consisting of clay, lime and sand intimately mixed. It has generally been supposed that the black colour is due to an admixture of organic matter, but Leather is of opinion that this cannot be the case, but that it must be due to the presence of some mineral substance. He also holds that these soils are not inordinately fertile. In the matter of phosphoric acid and nitrogen they are very poor. The fact that they do produce crops liberally, he thinks, is due to their power of retaining moisture and to their contraction, which not only forms deep and wide fissures, but causes the surface to crumble to a powder, which, getting carried into the larger fissures, thus brings about a continual inversion of the soil.

Manure.

As regards the manuring of cotton crops, it has been proved by experiment that cotton responds promptly and profitably to a judicious fertilisation. The following account is taken from the results of the experiments carried out by the United States Department of Agriculture.

Complete Fertiliser.

It may be stated in the first place that a complete fertiliser is needed for cotton, *i.e.* one containing soluble phosphoric acid, potash and nitrogen. Neither phosphoric acid nor potash give as good results separately as when combined. The most effective constituent is phosphoric acid, but nitrogen alone has little or no effect.

Cotton-seed meal.

The best form of nitrogenous manure appears to be cotton-seed meal and nitrate of soda. The proportions of the three constituents in a complete fertiliser should accordingly be approximately, nitrogen 1 part; potash 1 part; phosphoric acid 3½ parts. The quantity used per acre varies widely with the nature and condition of the soil, but the maximum should be an amount yielding nitrogen 20 lb; potash 20 lb.; phosphoric acid 70 lb. The profit from manuring cotton is much increased by antecedent proper preparation of the soil.

Soil-renovators.

Farmyard and similar bulky manures are said to be more efficient as soil-renovators than as specific fertilisers for cotton. The concentrated fertiliser should be applied in the drill, not broadcasted, at a depth of not more than 3 inches, and well mixed with the soil.

[*Cf.* Voelcker, *Improv. Ind. Agri.*, 1893, 47, etc.; McBryde, *Fert. for Cotton, U.S. Dept. Agri. Bull.* 1894, No. 14; Anderson, *Fert. required by Cotton, etc., Agri. Exp. Stat., Auburn, Alabama, Bull.* May 1894, No. 57; White, *The Manuring of Cotton*, in Dabney, *The Cotton Plant, etc.*, 1896, 169–96; Duggar, *Co-oper. Fert. Exper. with Cotton, Agri. Exper. Stat., Auburn, Alabama, Bull.* Feb. 1899, No. 102: Mollison, *Textbook, Ind. Agri.*, 1901, i., 22–3, 28–31; Francis Watts, *Manur-*

ing of Cotton, quoted in *Ind. Pl. and Gard.*, Aug. 12, 1905, 558; Clouston, *Artificial Fert. for Cotton in C. Prov.*, in *Agri. Journ Ind.*, 1907, ii., pt. ii., 116–22.]

Diseases.

V. DISEASES AND PESTS.—While many writers make mention of a "deterioration" of the cotton plant as having taken place in India, remarkably little has been said of the actual diseases of the crop. Compared with tea or coffee, Indian cotton can hardly be said to be affected with disease further than failure of crops through unfavourable seasons. Maxwell-Lefroy, Entomologist to the Government of India, has, however, recently issued some useful and suggestive *Notes on Cotton in Bihar* (*Bull. Agri. Res. Inst. Pusa*, Feb. 1904) in which he gives brief accounts of some 14 pests met with in the cotton of that province, of which 3 are at present known in Bihar only and 11 are general to the cotton tracts of India. He groups these pests under four sections as follows:—

Chief Pests.

(*a*) *Insects attacking the leaves and seen chiefly up to September.*—Under this series he places the following:—(1) hairy caterpillar; (2) cotton-leaf caterpillar; (3) the cotton bud-worm; (4) spotted boll-worm; (5) the white weevil; and (6) the cotton leaf-hopper. (*b*) *Insects in the stem:* (7) the stem-borer and (8) the stem-weevil. (*c*) *Insects in the boll:* (9) the spotted boll-worm and (10) the pink boll-worm; (11) the red cotton-bug; and (12) the dusky cotton-bug. (*d*) *Miscellaneous:* (13) the mealy bug; and (14) the large blister beetle.

Boll-worms.

Exotic Cottons.

He then concludes with a recommendation to destroy systematically all traces of the pests as they appear. In August and September a careful outlook should be kept for boll-worms, and all shoots or bolls showing signs of these should be destroyed. More recently Maxwell-Lefroy has issued a paper entitled *The Insect Pests of Cotton in India* (*Agri. Journ. Ind.*, 1906, i., pt. i., 49–61; also *Memoirs Dept. Agri. Ind.*, 1907, i., No. 2). This will be found to furnish fuller details of six of the more important of the pests, while a further note (*The Pests of Introduced Cottons*, 1907, ii., pt. iii., 283–5) furnishes a few particulars regarding the pests to which exotic cottons are liable.

The Cotton Mite

A curious disease often present to a large extent in India is known to the Natives as *gosai* or *tulsi* (the *Ocimum*-like). The former name ("the ascetic") denotes the non-flowering and fruiting of badly affected plants, and the latter their colour and general appearance seen at a distance. The leaves, at first large and exceptionally vigorous, ultimately curl up and become small, very numerous, and are then seen to be coated with a woolly formation known as *Erinosis*—a growth at first supposed to be of fungal origin but now definitely ascertained to be caused by a mite (***Phytoptus gossypi***). This perplexing pest is often very prevalent in Gujarat, as much as 5 to 10 per cent. of the bushes being thereby rendered more or less non-productive. It might be dealt with similarly to the treatment of *Erinosis* on the vine or other plants, namely by sulphur or kerosene emulsion. [*Cf.* G. F. Atkinson, *Diseases*, and L. O. Howard, *Pests*, in Dabney, *The Cotton Plant*, 1896, 279–350.]

Weevil-resisting Adaptations.

Resistant.—O. F. Cook has written a highly interesting and most suggestive report on *Weevil-resisting Adaptations of the Cotton Plant* (*U.S. Dept. Agri. Bull.*, 1906, No. 88). The form specially investigated is the *kekchi* cotton of Guatemala. This he describes as a dwarf annual short-season variety with numerous features which, in the absence of sufficient numbers of *keleps* (the so-called Guatemalan ant that kills the weevil), affords material assistance in protecting the crop against the ravages of that pest.

The plant in question matures very early and is more productive than might be expected. He classifies the protective developments into the following:—(1) those calculated to avoid the weevils by general habits of growth; (2) those which exclude the weevils or at least hinder their operations in the buds and bolls; (3) those which attract insect enemies such as the weevil-eating *kelep*; and (4) those which prevent the development of the weevil larvæ even after the eggs have been laid.

[*Cf. Publications of U.S. Dept. Agri.*:—Riley, *Cotton-worm and Boll-worm* (*Entomol.*), 1885, 1-381; and Bibliography, 382-4 (numerous plates): Malley, *Boll-worm of Cotton*, (*Entomol.*) *Bull.* 1891, No. 24; Howard, *Insects that Affect Cotton Pl.* (*Entomol.*), 1897, No. 47; Smith, *Wilt Disease of Cotton*, (*Veg. Pathology*) *Bull.* 1899, No. 17; also Orton, *Bull.* 1900, No. 27; Hunter, *The Mexican Cotton-boll Weevil*, *Farm. Bull.* 1904, No. 189; Quaintance, *The Cotton Boll-worm*, *Farm. Bull.* 1904, No. 191; Cook, *Habits of Kelep or Guatemalan Cotton-boll Weevil Ant*, (*Entomol.*) *Bull.* 1904, No. 49; *U.S. Yearbook Dept. Agri.*, 1904, 475–88, t. lxvii.; Hunter and Hinds, *Mexican Cotton Boll-weevil*, (*Entomol.*) *Bull.* 1904, No. 45; 1905, No. 51; Hunter, *Controlling Boll-weevil in Cotton Seed and at Ginneries*, *Farmer's Bull.* 1904, No. 209; also *Use of Paris Green*, *Farmer's Bull.* Nos. 211, 216; Quaintance and Brues, *The Cotton Boll-worm*, (*Entomol.*) *Bull.* 1905 No. 50; Lewton-Brain, *West Ind. Bull.*, 1904, v., No. 2, 178–94 (*Anthracnose*); 1905, vi., No. 2, 117–23 (*Black Boll.*).]

D.E.P., iv., 153-5.
Gins.

VI. CLEANING, GINNING AND BALING, ETC.—The scientific officers who accompanied Alexander the Great and his successors to India described the cleaning, ginning, spinning and weaving of cotton in such detail that it is matter of great surprise that these operations took so much time and study to be fully accepted in Europe. There may be said to have been known in India from time immemorial two forms of gins, viz. the foot roller and the *churka*. The former is very little used nowadays, though specially applicable to some of the forms of hard-seeded cotton. The latter consists of two rollers of wood, or of iron made to revolve towards each other by hand labour, communicated by a crank or wheel. The seed-cotton is presented at one side against the rollers, the lint passes through, and the seed falls down in front. This is improved by modern contrivances and worked by water power or steam.

Indian Gins.

The word "gin" is an abbreviation of "engine" which began to have the meaning of machinery shortly after the discovery of steam. The use of that name in India usually denotes the employment of foreign machines for separating lint from seed. A special gin was, for example, invented by Whitney to remove the firmly adhering wool of ***G. hirsutum***, and came to be known as the "saw-gin" because it consists of a series of blunt toothed circular saws made to revolve within the interstices of an iron bed which forms the base of a large hopper. The fibre is caught by the teeth and dragged through, leaving the seed behind. This was, however, found to injure the cotton and, moreover, was not necessary with the Sea Island and other cottons, where the lint separates readily. This led to Macarthy's gin, now very extensively employed for long-stapled cottons. In this contrivance the seed-cotton is drawn in by a leather roller between a metal plate, known as the "doctor," which is fixed tangentially to the roller. A blade called the "beater" is so adjusted as to strike the cotton repeatedly and thus cause the seed to fall out.

Modern Gins.

Saw-gin.

Macarthy's Gin.

It may be said, however, that no modern machine injures the lint and seed less than the Native *churka*—its one defect is its slowness, and therefore inaptitude for dealing with large quantities. To this fact is due a modern feature, and one of no small importance to the Indian

Churka.

Public Steam Gins.

cotton trade, namely the establishment all over the country of large public ginning and pressing mills, each situate in a convenient position to drain the produce of a tract of country within which it often has a monopoly. Naturally this has not proved an unalloyed blessing, though it has had some beneficial results. The cultivators hardly anywhere nowadays gin their own cotton, but carry the produce of their fields to the steam ginning mills. It has already been pointed out that widely different lints are in consequence inseparably mixed and ginned together, and moreover the cultivators are given, or purchase, mixed seed. This, it is believed, has rapidly equalised and lowered the Indian staple, thus rendering it imperative for the Government to organise some system of seed culture by which the special evolutions of centuries of cotton-growing may not be irretrievably lost, before the cultivators have learned the value of special selection and intelligent interchange of seed.

Public Steam Presses

In the official statistics published by the Government of India for 1906 there is said to have been in 1904, 951 cotton ginning, cleaning and pressing mills that gave employment to 85,559 persons. *Thacker's Directory* for 1905 enumerates 73 pressing and 47 ginning mills as those of chief interest. These figures show the extent to which the ginning and pressing of cotton have assumed importance.

Economy in Freight.

The necessity for economy in freights was one of the chief arguments that gave birth to cotton presses. But that consideration would seem to have engaged attention from the very earliest records of raw cotton being exported from India. The Rev. Philips Anderson has shown that as early as 1684 special presses were sent out from England to Surat. For many years the pressing and baling of cotton were done almost exclusively in Bombay: nowadays the pressing is done at the ginning factories.

[*Cf.* Royle, *Cult. and Comm. of Cotton in Ind.*, 1851, 537–44; Forbes Watson, *Cotton Gins and the Cleaning and Quality of Ind. Cotton*, 1879; *Ind. Text. Journ.* (*ser. of art. on Gins by an Indian Engineer*), Sept. 1897, 300, to June 1902; Brooks, *Cotton, etc.*, 1898, 202–39; *Text. Mercury, Cotton Ginning in the United States*, June 1903; *Cotton in W. Africa, L'Agri. Prat. des Pays Chauds*, 1904, iii., No. 18; Dabney, *The Cotton Plant, etc.*, 1896, 360–5; *Circular regarding The Lowry Bale in Planters' Compress Company*, 1899.]

Cotton-seed.

Exports.

VII. COTTON-SEED: AN ARTICLE OF CATTLE FOOD AND SOURCE OF OIL.—One of the modern aspects of the Indian traffic in oil-seeds may be said to be the sudden development of a foreign demand for cotton-seed, mainly in the United Kingdom. In 1898–9 the exports were returned at 37,000 cwt.; in 1899–1900 at 43,000 cwt.; in 1900–1 they suddenly advanced to 225,000 cwt.; in 1901–2 they increased tenfold, and became 2,036,000 cwt.; in 1902–3 they still advanced, viz. to 3,974,000 cwt.; in 1904–5 were 2,518,897 cwt.; in 1905–6, 3,891,339 cwt.; and in 1906–7, were 4,387,534 cwt. Thus, within five years, from being utterly insignificant the exports of cotton-seed sprang into the second place in quantity and the fourth in value of all the oil-seeds exported from India. This has very possibly been a consequence of the discovery of successful methods of hulling the seed, the decline of the American supply, or simply the extended use of cotton-seed oil as a material employed in the preparation of lard and margarine. But it is significant of India's consumption of oils and oil materials that even the very large exports of 1902–3 and subsequent years represent but from 10 to 20 per cent. of the amount available. Mollison (Inspector-General

Lard and Margarine.

of Agriculture) in a paper on cotton oil-seed (*Agri. Ledg.*, 1903, No. 9), pointed out that the seed of the United Provinces is best suited for the oil trade.

Oil.

Decorticated.

Cooking.

Olive Oil Substitute.

Cake.

Oil.—After the cotton (lint) has been removed, the seeds are often subjected to a treatment calculated to remove any still adhering particles of floss. The cleaned seeds are then cut through and decorticated. It is particularly necessary that this should be done, since the cake after expression of the oil is used as an article of cattle food, for which it is generally believed it would be unfit were the hulls attached. The quantity of oil usually present averages from 20 to 25 per cent. of the weight of seed. But the process of manufacture varies according to the purpose for which the oil is destined. The decorticated seeds are subjected to cold pressure, when from 10 to 12 per cent. of oil is obtained. This is of a fine quality, almost devoid of taste, and is accordingly largely used in cookery, being specially valued for frying purposes. It is often sold in mixture with olive oil or is employed as an adulterant for the cheaper grades of that oil, or pure cotton-seed oil is sold under the name of olive oil. It is also extensively utilised in the production of lard. The cake obtained from this cold expressed seed is next subjected to a further pressure, by the hot process, when an extra supply of oil is obtained up to 10 per cent. By other methods from 15 to 20 per cent. of oil is at once expressed by the hot process, from decorticated or undecorticated seed, and the cake allowed to carry the balance. It is, in fact, generally believed that the presence of a fair percentage of oil is essential, otherwise the cake is useless for cattle food. But it should be here added that very little cotton-seed is in India pressed for oil, though valued as a fertiliser.

Composition of the Oil.

The sp. gr. of refined cotton-seed oil varies from 0·922 to 0·924, its iodine absorption is from 105 to 109, and its saponification equivalent ranges from 285 to 294. It has a slight tendency to dry, and congeals at 32° to 45° F. By freezing the oil the glyceryl salts, which are solid at low temperatures, are separated and constitute cotton-seed stearin, an important ingredient of margarine. No information can be discovered regarding the extent to which cotton-seed oil is prepared in India. A note by Burkill records his having inspected in Burma a ginning factory and oil mill owned by Jamal Brothers. The cake prepared is exported and the oil refined. The husk is used as fuel.

Cake.

Seed often neglected.

Cattle Food.

Undecorticated Cotton Cake.

Cake.—From fairly ancient records regarding the Indian cotton trade, mention is made of the seeds as a useful by-product, employed to fatten cattle. It is said that they do not at first like the seed but soon take to it very kindly, and may be given a daily ration of as much as 6 lb. In the Nagpur Experimental Farm, 2 seers of cotton-seed are given daily to bullocks in place of oil-cake. Nevertheless in many parts of the country the seed is not valued even up to the present day; in fact in India as a whole, the seed can hardly be described as anywhere used by the Natives in the production of oil. The self-same cultivators who grow the cotton plant will raise special oil-yielding crops, the oil of which in some respects may be even inferior to that of the cotton-seed which they entirely neglect. This may proceed from the very generally accepted belief that cotton-seed cake is less wholesome than the whole seed. Mr. R. W. Bingham, who specially investigated the Indian oil-yielding plants half a century ago, said that cotton-seed was more used as an article of cattle food than as an oil-producing seed, and that the seed was considered a better food for working bullocks than even grain. He then added that he did not think it would pay to export the seed since owing to the fibre adhering to it, and perhaps other causes, it is very liable to heat and deteriorate in bulk. The fact that there is to-day a large and prosperous export trade in Indian cotton-seed shows the often unexpected turn that discovery or necessity gives to the trade commodities of the world. In fact, in the *Journal of the British Board of Agriculture*, Voelcker shows that recent results are distinctly in favour of Bombay undecorticated cotton cake, as compared with Egyptian, especially when its lower price is borne in mind.

Various machines and processes for removing the fuzz from cotton-seed have been patented. Some burn off the velvet, others chemically destroy it, and still others mechanically brush it off. It is no doubt much desired to obtain an effectual and cheap removal of the fuzz, but meantime it is interesting to learn that undecorticated seed-cake finds a market. The chapter on Feeding Value of Cotton-seed by W. Kilgore (in Dabney, *The Cotton Plant*, 1896, 385–422) will be found to give full particulars on this subject. Other publications of interest are the summary of Dr. T. Thorpe's views (given in *Journ. Board Agri.*, 1898 205–8).

Hulls and Waste Stems.

Paper Material.

Hulls and Waste Stems.—Recently it has been found that the hulls or entire seeds may be utilised in the manufacture of a superior grade of writing paper. The stubble, after the cattle have devoured all the edible portions of the plants left on the removal of the lint crop, may be decorticated and a useful fibre thus obtained. It is stated that 5 tons of stubble give a ton of bark, and that a ton of bark yields 1,500 lb. of clean fibre that can be even used as a jute substitute. [*Cf.* Dabney, *l.c.*; Connell and Carson, *Steer-feeding*, in *U.S. Dept. Agri. Exp. Rec.*, 1897–8, ix., 269; Lindsey, Holland and Jones, *Cotton-seed for Milch Cows*, 1898–9, x., 679–81; Brooks, *Cotton, etc.*, 1898, 309–54; *American Cotton Seed Indust.*, *Board of Trade Journ.*, 1900, 637; Mollison, *Textbook Ind., Agri.*, 1901, i., 126–8; Mukerji, *Handbook Ind. Agri.*, 1901, 288–90; *Journ. Board Agri.*, June 1901, viii., No. 1, 41–3; Blount and Bloxam, *Chem for Engin. and Manuf.*, 232; Mollison, *Offic. Mem. on the Cotton Seed Oil Indust. and Estab. of Cotton Seed Oil Mills in Ind.*, *Agri. Ledg.*, 1903, No. 9; Burtis, *Cotton Seed Meal as Pigs' Food*, *U.S. Dept. Agri. Exper. St. Repts.*, 1901–2, xiii., 583, 881–2; 1903–4, xv., 392–3; *Egyptian and Ind. Cotton-seed Cake*, *Journ. Board of Agri.*, 1904, xi., No. 5, 289–91; *Rept. Exper. Farms Canada*, 1905, 176; Gilchrist on *Bombay Rough Cotton-cake*, in *Board of Trade Journ.*, 1905, 231; *Fert. and Feeding Value of Sea Island Cotton Seed*, in *West Ind. Bull.*, 1905, v., No. 3, 223–32; Sly, *Cotton Seed-oil Indust.*, *Agri. Dept. Cent. Prov. Bull.*, No. 9; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 361–8.]

Cotton Cell.

Formation.

VIII. THE COTTON FIBRE.—The cotton fibre is a unicellular hair arising from the fibril layer of the seed-coat. If taken from the seed of a ripe but unopened pod, it will be found to be a straight, flattened, hollow tube, not quite cylindrical but thickest a little below the middle, tapered abruptly below and more gradually to the apex. With growth, the cell wall thickens, becomes thinnest along the centre and thickest towards what may be called the margins. In consequence of this unequal thickening, maturity is marked by the thinnest parts shrinking most and thus causing the cell to become spirally twisted on itself. The cotton cell may hence be spoken of as a fibril from ½ to 2 inches in length, twisted spirally. Wiesner (*Die Rohst. des Pflanzenr.*, 1903, ii., 240–1) gives a series of measurements to show that the broadest section generally falls a little below the middle. It is a noteworthy circumstance, and moreover one of practical importance, that the floss taken from a capsule always consists of fibres of various lengths. Allard (*U.S. Dept. Agri. Bureau Pl. Indust. Bull.*, 1907, No. 111, 13-5) has shown that this is frequently a consequence of certain cells separating from the seeds and uniting with other cells, thus producing the apparent though not real greater length. This discovery may prove of great value. Average Indian floss does not come to three-quarters of an inch in length, while some varieties of Sea Island have a staple two inches long. Evan Leigh (*The Science of Modern Cotton Spinning*) gives the following measurements as representative of the lengths (maximum) of cotton staples:—New Orleans, 1·16 inch; Sea Island, 1·80 inch; Brazilian, 1·31 inch; Egyptian, 1·52 inch; Indian (indigenous), 1·02 inch; Upland American grown in India, 1·21 inch; Sea Island grown in India, 1·65 inch. [*Cf.* Watt, *l.c.*, 1907, 25–51.]

Lengths of Standard Staples.

Cell-wall.

Structurally, the cotton fibre consists of a wall of almost pure cellulose, lined by a delicate layer of protoplasm, which disappears early in the growth of the fibre as the secondary placed deposits increase and a central core of endochrome is formed—the colouring material of the cell. The wall constitutes from one-third to two-thirds of the diameter of the cell. Recently an exceedingly interesting discovery was made by H. de Mosenthal (*Journ. Soc. Chem. Indust.*, March 31, 1904), namely that the cotton cell-wall consists of two layers, termed the outer and inner, which are pierced by minute pores, leading into the lumen of the fibre. These

Dead Cotton.

pores, hitherto unobserved, offer an explanation of the way moisture penetrates to the interior. Among the ripe flosses of every grade is often present a certain percentage of quite unripe hairs. These are very thin, have weak cuticles, and show no twisting; they are the cause of much depreciation, since they cannot be worked up nor dyed in the same manner as fully formed flosses. In practical work such hairs are known as "dead cotton." According to Hanausek (*Tech. Mikroskopie*, 1900, 5–8; also Winton and Barber, transl., 1907, 58–68), *dead cotton* is commonest in coarser grades (Levantine and Indian) and rarest in Sea Island. [*Cf.* Flatters, *The Cotton Plant*, 1906, 59–92.]

Commercial Properties.

The commercial value of cotton is chiefly affected by the length and uniformity of the staple. Silkiness, fineness, strength, cleanness and colour are the other important factors. Tables showing the physical properties of the various staples of commerce are given by Hannan (*Text. Fibres Comm.*, 1902, 94–6), while Flatters contributes micro-photographs and comparative descriptions of the flosses of the following trade samples:—Florida, Brown Egyptian, New Orleans, Peruvian Rough and Hinganghat. As offered for sale, cotton always contains moisture varying from 7½ to 12½ per cent. over absolute dryness. With regard to the influence of moisture on spinning, the reader should consult Dobson (*Humidity in Cotton Spinning*, Sept. 17, 1894).

Mercerised.

When immersed in a solution of caustic soda, cotton fibre undergoes an important change. The cell-walls swell and acquire silky gloss. Cotton so treated is known as mercerised. The process was invented and patented in 1851 by John Mercer, a Lancashire calico-printer. The swelling of the fibre causes a shrinkage in length, it becomes more transparent, gains in strength and weight, while its capability for taking up certain dyes is vastly increased.

Chemistry.

Chemically, the mature fibre consists of almost pure cellulose with about 3 per cent. of other substances. The most important of these are cotton wax, fatty and pectic acid, endochromic colouring matter, and albuminous substances. The fibre is insoluble in water, alcohol, ether, fixed and volatile oils or vegetable acids, but soluble in strong alkaline solutions and is decomposed by concentrated mineral acids. Cuprammonia causes a complete disorganisation of the cellulose deposits.

[*Cf.* Royle, *l.c.*, 1851, 122–6; Bolley, *Chem. Technologie der Spinnfasern*, 1867; Benno Neiss, *Die Baumwollenspinnerei, etc.*, 1868; Bowman, *Struct. of Cotton Fibre in Relat. to Tech. Applicat.*, 1881, also ed. 1908; Hugh Monie, *The Cotton Fibre, its Structure*, etc., 1890; Morris, *Cantor Lect. Comm. Fibres, Journ. Soc. Arts*, March–April, 1895, 6–7; McBryde, *Chem. of Cotton*, in Dabney, *The Cotton Plant, etc.*, 1896, 81–141; Hanausek, *Mercer. und Deformation der Baumwolle*, Vienna, 1897; Thorpe, *Dict. Appl. Chem.*, 1898, i., 613; Cross and Bevan, *Paper Making*, 1900, 95–6; Semler, *Trop. Agrik.*, 1903, iii., 497–502; Hubner and Pope, *Infl. of Reagents on Tensile Strength of Cotton Yarn*, in *Journ. Soc. Chem. Indust.*, Jan. 31, 1903, xii., 70–9; Clayton Beadle, *Fibrous Constit. of Paper Cotton in Tech.*, June 1904, 567–74; July, 60–5; Hield, *Mercer. of Cotton*, in *Text. Journ.*, June 15, 1905, 275–6; C. B. Williams, *Cotton Plant, N. Carolina Dept. Agri. Bull.*, 1906, xxvii., No. 9.]

IX. INDIAN MANUFACTURES.

Hand-loom Weavers.

The cotton manufactures of India may be said to be referable to three groups:—1. Indian Hand-loom goods. 2. Indian Power-loom goods. 3. Foreign Power-loom goods.

These three have to be clearly borne in mind both in connection with the present chapter and that on trade. The late Sir James Westland said of India, and with some force, that "weaving is for the most part the pursuit of the bye-time of the persons who weave." That is doubtless the condition in many parts of the country to-day, but here and there centres of professional hand-loom weaving still exist where the village weaver holds an honoured position. He, in fact, turns out a fair portion of the dresses worn by the more conservative and orthodox members of the community. Increased prosperity of these hard-working and highly deserving craftsmen was entertained by some writers as likely to ensue when the repeal (in 1896) was announced of the tax on yarn, conjointly with the imposition of a countervailing duty on power-loom manufactures, both foreign and Indian. It was thought that all that need further be done, to restore and uphold the hand-loom industry, was to teach the Native Fly-shuttle. weavers the use of the fly-shuttle and a few other such contrivances.

A century ago or more these very contrivances had in Europe been found quite useless in the contest with steam, but it was presumed conditions existed in India that raised the possibility of hand-loom improvement to a position of supreme importance. Hence it was urged, among other considerations, that "the hope of the hand-loom industry lies in the production of goods of a kind which cannot profitably be made by the power-loom, such as those compounded in an intricate fashion or made in a very complicated pattern. The fact that after a long struggle with the products of the mills, the hand-loom industry still survives, may be held to show that it has vitality to preserve it yet for many years." It would Hopeful Markets. very possibly be nearer the truth to say that the hope of the hand-loom weaver lies in the restriction of his operations to lines that are too small to tempt the competition of the power-loom worker. It may, in fact, be safely affirmed that there is nothing either too fine in texture or too complicated in pattern for the power-loom manufacturer to produce. His advent on the field is alone restricted by the possibilities of profit. The finest Dacca muslins and the most intricate Kashmir shawls can be and have been produced by machinery cheaper than by hand labour. But there are markets eminently suited to the hand-weaver, such as the production Special *sar* or *lungis*. of special *saris* and *lungis* of a particular shape and size that the power-loom producer does not successfully contest.

There is this also in favour of the hand-loom weaver—he can purchase the very best English spun yarn and produce a quality of fabric admittedly superior to the very best power-loom textiles ordinarily turned out by the Indian mills. But, let it be repeated, his safety lies in the goods he manufactures being of a fancy or special nature, meeting local markets known to him, rather than in regular commercial articles intended for large markets.

Centres. ***HAND-LOOM INDUSTRY.***—It would occupy much time to review, however briefly, the chief centres of hand-loom production and the class of goods turned out. The figures given within brackets, in the enumeration that follows of the cotton-weaving centres of India, denote the number of *steam-power mills* in 1904. The square brackets show the provincial totals and the round brackets the district totals, while districts without figures have no power-loom mills.

Factories. The districts most famed are:—PANJÁB [8]—namely, Dera Ismail Khan, Multan, Shahpur, Kohat, Peshawar, Lahore (2), Armitsar (1), Delhi (5), Rohtak, Sialkot, Ludhiana, Gurdaspur, and Jallandhar. Thus 13 districts of the Panjáb are noted for their cotton manufactures, and three of these possess power looms. Similarly the UNITED PROVINCES [9]—Benares, Bulandshahr, Sikandrabad, Azamgarh, Lucknow, Cawnpore (4), Mirzapore (1), Aligarh (1), Agra (3), Fyzabad, Rai Bareli and Rampur. CENTRAL PROVINCES [7]—Nagpur (2), Umrer, Bhandara, Burhanpur, Sambalpur, Chanda, Hinganghat (2), Jabbalpur (1), Pulgaon (1), and Raj Nandgaon (1). BERAR [2]—Badnera (1), Akola (1), and Ellichpur. RAJPUTANA AND CENTRAL INDIA [4]—Kota, Gwalior, Indore (1), Ujjain (1), Ajmir-Merwara (1), and Kishengarh (1). HYDERABAD [3]—Aurangabad (1), Hyderabad town (1), and Kulburga (1). BENGAL [10]—Calcutta (7), Howrah (3), Bardwan, Birbhum, Serampore, Nadia, Murshidabad, Jessore, Dinajpur, Rangpur, Bogra, Dacca, Tippera, Faridpur, Chittagong, Patna, Shahabad, Saran, Monghyr, Bhagalpur, Cuttack. ASSAM—Sibsagar and Manipur. BOMBAY [141]—Bombay City (84), Ahmedabad (32), Broach (4), Surat (3), Baroda (1), Veramgam (2), Wadhwan (1), Nariad (1), Julgaon (1), Bhavnagar (1), Hubli (2), Sholapur (3), Belgaum (2), Dharwar (1), Bijapur, Poona (2), Nasik, Thana Morui (1). SIND—Hala, Narapur and Karachi. MADRAS [17]—Madras town (4), Chingleput (Godavari), Nellore, Vizagapatam, Masulipatam, Salem, North Arcot (Arni), Coimbatore (1), Bellary (1), Tanjore, Madura (1), Pondicherry (5), Tinnevelly (2), Tuticorin (1), Calicut (1), and Travancore (1). MYSORE [2]—Bangalore (2) and Shimoga. BURMA—A domestic industry only.

Chief Considerations.

Fine Muslins.

Dacca.

Counts.

Sites for Factories.—The selection of sites for steam-power factories has been governed mainly by three considerations :—(1) proximity to supply of raw cotton ; (2) the existence of an indigenous industry and therefore of a community of professional weavers who might be drawn upon for labour ; and (3) facilities of transport to important markets. As indicated by the figures in the above enumeration, the modern power-loom industry has followed very much in the path of the ancient hand-loom craft. The fine muslins of Dacca, Arni, Chanderi, Kota, Rohtak, Benares and other localities are still being manufactured. Many writers speak of Dacca muslins as being a product of past ages. So long ago as 1820 Mr. Walter Hamilton, one of the Company's officials resident in Dacca, prophesied that with the decline and fall of the Delhi Court the loss of the fine muslins of Dacca might be expected, since the demand for these expensive fabrics very possibly would cease. But at the Delhi Durbar Exhibition of 1903 some remarkably fine muslins of Dacca were sold on behalf of the manufacturers —and these were very nearly as fine as the samples in the Calcutta Museum, which were procured in 1884 and made somewhere about that date. There is no very ancient sample of these muslins known anywhere, so that we have little by which to compare the famed ancient textiles with the modern productions. But the examples presently being turned out would measure 400's or 450's, while English power looms have been known to produce 600's. Cotton yarns are said to be counts of 20's, 30's or 400's, when not more than a like number of hanks of 840 yards go to the pound avoirdupois.

Failed to use American Staples.

Swells on Bleaching.

The point of interest in these Dacca muslins, however, lies in the fact that the hand spinners of Dacca *are* producing to-day yarns of a fineness that no machinery in the world could spin from the inferior staple which they use. Dr. Taylor wrote, in 1840, that the Dacca spinners failed to use the fine American cottons, and gave as their reason the fact that the English yarn swells on bleaching, while that of Dacca shrinks and becomes finer and stronger. It would thus appear that the European spinner, with all his beautiful machinery, may still have something to learn from the hand spinner, and that something might possibly lead to his being able to spin shorter staples than he at present considers indispensable. This hint seems worthy of careful investigation (see pp. 594–5, 607).

Special Indian Goods.—The artistic cottons produced in India are referable to two main heads—long cloths or damasks and muslins, plain or figured. The patterns are usually woven, not printed. When checked

Hindu Colours.
Muhammadan Colours.
Men's Garments.
Women's Garments.
Chadar.
Pagri.
Kamar bands.

they are in North India commonly termed *kheses*, to the South *gabrúns*: when striped they are *susís*. The usual colours are dark red for Hindus, dark blue for Muhammadans, in both cases interwoven with white. The *dhoti* or *dhotar* is worn by men and is a piece of plain cloth generally having a coloured border and measuring about 5 yards in length and 1¼ yards in breadth. It may be made locally or imported. The *sari* or woman's upper garment varies greatly according to the wealth, position, caste, etc., of the wearer as regards the material, quality or degree and nature of ornamentation. With finer materials it is usually a gauze, and is still very largely hand-loom work. The *sári* is, from an art point of view, perhaps the most picturesque of all Indian garments. The *chadar* or shawl is a sheet usually about three yards long and half as wide. It is worn by men, but by women of certain castes only. The *pagri* or *lungi* (turban) is a long narrow strip of cloth worn by men round the head or around the waist as a *cummer-band* (*kamar-band*). Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.*, 1662, 27, 83) discusses the cotton manufactures of Broitschia (Broach) and of the "*comerbants*" or girdles of silk and fine cotton.

Exact Shape and Colour Essential.

Throughout India certain localities are famed for the quality, design, etc., of their *kheses*, *gabruns*, *susis*, *dhotis*, *saris*, *chadars*, *pagris* and *lungis*, etc. The merchant who may desire to open up a trade in manufacturing and supplying these special goods must ascertain the exact size and shape, the particular quality and colour in demand in each locality. The mere fact of offering a superior quality of goods is no inducement to trade. Few communities in the world are more conservative regarding their garments than are the various races and castes of India.

Jamdanis.

The figured or flowered muslins—*jamdanis*—are by far the most artistic of the cotton manufactures. These are literally cotton brocades, the patterns or flowers being formed by spools carrying special threads of cotton, silk, wool or gold, that are thrown by hand within the warp and thus become supplementary to the weft. The centres most famed for these artistic textiles are Dacca, Santipur, Chittagong, Tanda and Chanderi. The flowered muslins of Calcutta and Lucknow are needle-embroidered (*chikan*) work.

Mills.
Foundation of Indian.

STEAM-POWER MILLS: Spinning and Weaving.—The first cotton mill founded in India was at Fort Gloster (the Bowreah Cotton Mills Company, Ltd.), near Calcutta. This received its charter in 1818 as a cotton mill, a coffee plantation and a rum distillery. Some years later the first of the Bombay series was established, namely the Bombay Spinning and Weaving Company (1851), and ten years later there were a dozen mills and 338,000 spindles at work. In 1879 the number had increased to 58 mills and 1,500,000 spindles, giving employment to 39,537 persons; in 1886-7 there were 90 mills with 16,926 looms and 2,202,602 spindles; in 1896-7, 155 mills, 37,303 looms and 3,984,023 spindles; and in 1901-2, 194 mills, 41,815 looms and 4,992,249 spindles. Within the decade ending 1901-2 the number of looms had increased by 69 per cent., and of spindles by 52 per cent. The capital invested in the 194 mills has

Capital

been published as Rs. 16,01,40,384 *plus* £650,000; in 1904-5 they had still further expanded, namely to 203 mills with a capital of Rs. 15,97,41,301 *plus* £1,067,245, and had 47,305 looms and 5,196,432 spindles. In the *Moral and Material Progress of India* (1905-6, 176) the following statement occurs:—"There were at the end of 1905-6 in British India and Native

States 204 cotton mills containing 52,300 looms and 5,293,800 spindles, and giving employment on an average to 212,700 persons every day. Of these, 104 were exclusively spinning mills, eight were exclusively weaving mills, and in the rest both spinning and weaving were carried on. The capital invested, including an estimate for ten companies worked by private proprietors, for which accurate returns are not available, was £10,690,000 (paid-up capital and debenture loans). The industry is located, as regards 70 per cent. of the mills, in the Bombay Presidency, while there are 19 mills in the territory of Native States and in French possessions in India." Between the years 1893 and 1900 the industry was depressed, profits being affected by the disturbances in exchange relations with the Far East which followed the closure of the Indian mints, by over-production, by plague, by poor crops, by famine and by the disturbances in China. Since 1901 there has, however, been a satisfactory improvement. The Indian mills give permanent employment to 186,271 weavers, besides occasional employment to large numbers of cultivators, carters, boatmen, etc., etc. By way of comparison, it may be stated that in 1904 there were 2,077 mills in Great Britain; 1,201 in the United States; 500 in Italy; 420 in France; 390 in Germany; 304 in Russia and Poland; 257 in Spain; 203 in India; 64 in Japan; and 22 in Canada—the grand total of the world, including all others not specified, being 6,014 cotton mills.

Depression.

World's Cotton Mills.

Wages of Indian Operatives in the Cotton Industry.—It would be impossible to furnish an average wage of all the employees in a mill that would be of any value, since the different classes of labour naturally command different wages. Still more impossible would it be to produce a figure or set of figures that could be regarded as applicable to the whole of India. The following returns taken from an actual statement given by the Government of India (in the publication known as *Prices and Wages*, 1906) are, however, highly instructive and indicate the average wages (piece-work and monthly wage, in Rs.) paid at the Manockjee Petit Mills of Bombay in January of each year from 1882 to 1906:—doffer, in 1882 Rs. 5, in 1906 Rs. 6·5; winder, in 1882 Rs. 5 to 7, in 1906 Rs. 6 to 9; rover, in 1882 Rs. 14 to 16, in 1906 Rs. 12 to 15; reeler, in 1882 Rs. 5 to 7, in 1906 Rs. 7·5 to 9; warper, in 1882 Rs. 15 to 17, in 1906 Rs. 12 to 20; weaver, in 1882 Rs. 14 to 20, in 1906 Rs. 12 to 30; jobber, in 1882 Rs. 35 to 45, in 1906 Rs. 30 to 50. These are only a few out of the many, but they are sufficiently representative to show the wide range of wages earned, and to indicate the immense importance of the industry to a locality like Bombay that can lay claim to 79,270 men, 28,412 women, 13,590 young persons, and 5,883 children, a total of 127,155, all earnings wages on the scale indicated (the special cases mentioned), manifesting the highest, the lowest, and the medium class earners.

Wages.

TAXATION.—Cotton goods imported into India were for many years subject to a duty of 5 per cent. This tax existed, for example, before the date of the Mutiny and was continued when the East India Company ceased to exist. It was raised to 10 per cent., then in 1864 reduced to 7½ per cent., and in 1875 to 5 per cent. with lower rates for twists and yarns. But, by a Resolution of the House of Commons, 1877, it was ruled that these duties, being protective, should, as early as possible, be repealed. Accordingly, in 1882, the Indian import tariff was practically abolished and no fresh duties were levied until 1894. In March of that year import duties were charged on most articles except cotton goods. The omission of cotton was vigorously opposed by the Indian manufacturers, and a few

Taxation.

Imports Excised.

Local Production Taxed.

Power-loom Goods Taxed

Net Duty Collected.

months later the bill was accordingly amended and certain cotton imports were excised. The cotton goods and yarns imported into India are mainly of the finer qualities, whereas those manufactured in India (chiefly on account of the inferior quality of the local staple) are of the lower grades. But with the medium-class goods, the foreign supply overlapped the local production, and hence, with a view to take away the protective character of the customs duty, it was decided to impose an excise duty of 5 per cent. on the medium qualities of yarn produced in India. Technically this is expressed by saying that all Indian-produced yarns above 20's were taxed. It was soon found, however, that this endeavour to equalise the burden of taxation on the two great competing sets of cotton manufacturers (Indian and Foreign) was not a success. In 1896 a further Act was accordingly passed by which cotton yarns were freed from taxation and a uniform duty of 3½ per cent. imposed on all woven goods imported into India or manufactured by Indian power-loom mills, the village hand-loom industry being exempted. In 1902, B. J. Padshah wrote a *Memorandum on the Profits of the Cotton Industry of India and the Cotton Duties*, to which the editor of *The Times of India* contributed an Introduction: these papers will richly reward perusal. They may be accepted as setting forth present Indian commercial opinion. Padshah hinges the whole of his critical and very able review on two conceptions that he endeavours to disprove, viz. " that the average profits of the Mill Industry are high ": " that the Cotton Duties would be really paid by the consumer of cotton goods and not by the producer." The net duty collected on the goods manufactured by the Indian mills for the four years 1901-2 to 1904-5 was, 1901-2, Rs. 17,77,965; 1902-3, Rs. 18,91,010; 1903-4, Rs. 20,95,149; and 1904-5, Rs. 24,06,976.

[*Cf.* Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, ii., 261-5; Montgomery Martin, *Hist. E. Ind.*, 1838, i., 328-9, 341-51, 353-8, 546-9; ii., 558-62, 973-6; iii., 322-4, 327-9; *Admin. Repts. Andaman and Nicobar Islands*, 1886-1904; Mukharji, *Art Manuf. Ind.*, 1888, 315-31; Collin, *Existing Arts and Indust. Beng.*, 1890, 7-8; Havell on Indian Industries, the Fly-shuttle; Chatterton, in *Ind. Text. Journ.*, 1899-1905; Max and Bertha Ferrars, *Burma*, 1900, 58-61; *Settl. Rept. Meiktila*, 1900, 32-5; J. Sturrock, *Man. S. Canara Dist.*, ii., 145-7; *Monographs, Cotton Manuf.*:—Banerjei, *Bengal*; Arnold, *Burma*; Blennerhassett, *Cent. Prov.*; Sammon, *Assam*; Silberrad, *United Prov.*; Francis, *Panjáb*; Enthoven, *Bombay*; Edgar Thurston, *Madras*; numerous articles in the Indian Press, more especially *Ind. Text. Journ*; Talcherkar, *Reels and Reeling in Indian Mills*, in *Ind. Text. Journ.*, Feb 1901; Geo. Cecil, *Cotton Mills in India*, in *Text. Mercury*, 1901; *Times of India*, 1901-2; *Madras Mail*, 1901-2; *Englishman*, 1901 *Pioneer*, 1902-3; Watt, *Ind. Art at Delhi*, 1903, 236-89; *Measurement of Widths of Piece Goods, Beng. Chamber of Comm. Rept.*, 1904, 152-63; *Short Reeling of Yarns*, 399-424 (including Rept. of Committee appointed by Government of India to consider and propose measures for suppression of fraudulent short-reeling). Combes in *Soc. Arts*, 1904, lii., 734; Temple, *Text. Mercury*, 1904; *Ind. Agri.* (many passages); Tozer, *The Manuf. of Great Britain*, in *Journ. Soc. Arts*, 1905; *Imp. Gaz.* iv., 262-5.; *Repts. of Bombay Mill-owners' Assoc.*; *Board of Trade Journ.*, 1905; *The Textile Recorder*, Feb 15, 1908, 302; etc., etc.]

X. INDIAN TRADE IN RAW COTTON AND COTTON MANUFACTURES, BOTH LOCAL AND FOREIGN.

Trade in Raw Cotton.

RAW COTTON.—So much has already been said regarding the Indian Cotton Trade that this account may be fittingly drawn to a close by a few short paragraphs devoted to the more important sections under which transactions are ordinarily conducted. The total area (according to the *Final Memorandum* of the Commercial Intelligence Department for the year 1906-7) occupied by cotton was 14,918,000 acres in 1904-5, with

Production.

Area under Cotton.

Hand-spinning Rare.

a crop of 3,826,000 bales; in the following year the corresponding figures were 21,072,000 acres and 3,426,000 bales; and for 1906-7 they are estimated at 22,344,000 acres with 4,908,000 bales. These are the actual returns, as also the estimates for all India (British and Native States). In 1904-5 the yield of the British districts alone came approximately to 3½ million bales, while the exports and mill consumption together came to 3,390,413 bales. In 1905-6 the *Final General Memorandum* estimates the yield in British districts only at about 2,244,000 bales, while the mill consumption is said to have been 2,025,733 bales and the exports approximately 2,000,000 bales. Going back to previous years, in 1903-4 the acreage was 18,042,781, the outturn 3,168,113 bales; the foreign exports were 7,931,075 cwt. (or 2,220,701 bales), thus leaving a balance (*plus* the produce of Native States) of 947,412 bales as available to meet local demands. But the scarcity of cotton in Europe, then prevalent, very possibly created a stronger demand for Indian cotton than can be regarded as normal. It may, therefore, be desirable to examine the returns of the year previous. In 1902-3 the crop was 16,581,046 acres, yielding 3,367,030 bales, and the exports to foreign countries 1,692,545 bales, thus leaving a balance to meet local demands of 1,674,485 bales, or exactly one-half the production. At the present day the hand-loom weavers rarely spin their own yarn, but purchase supplies either of the imported or of the Indian mill-spun yarn. It may thus be accepted that the balance of production over the demands of the Indian mills is available for the foreign markets.

Exports.

Total Value.

Exports.—During the past seven years the following were the exports in cwts. and rupee values:—1900-1, 3,575,703 cwt. and Rs. 10,12,74,007; 1901-2, 5,700,914 cwt. and Rs. 4,42,60,933; 1902-3, 6,044,806 cwt. and Rs. 14,75,71,981; 1903-4, 7, 931,075 cwt. and Rs. 24,37,61,464; 1904-5, 5,657,743 cwt. and Rs. 17,43,46,872; 1905-6, 7,399,534 cwt. and Rs. 21,34,15,195; and 1906-7, 7,400,839 cwt. and Rs. 21,94,84,609. These figures thus show an average valuation of close on fifteen crores of rupees; and if we assume an equal valuation for the share of the crop retained (well under the mark), the total value of the cotton raised in India would not be far short of thirty crores, or say £20,000,000.

Change in Staple.

Low count Yarns.

Low Grade.—Reference has already been made to the degeneration that has taken place in the staple grown in India. The cultivators have allowed themselves to be driven into the production of an inferior staple or they have deliberately selected to grow that class of cotton. If the manufacturer would pay no more for a long than for a short staple, the Indian cultivators naturally sought out the plant that could give them the highest and most profitable yield. It is not surprising, therefore, that within the past thirty years or so the fine long-stapled cottons of India—the cottons that at one time were much admired and found a ready sale in Europe—have gradually disappeared, and that inferior but highly productive, early ripening and hardy races have taken their places (or are rapidly doing so). But the change that has come over the cotton industry may be spoken of as a consequence of various influences. The Indian mills having at hand an inferior staple, concentrated their attention on low-count yarns and inferior piece goods. So successful were they that in a remarkably short time they closed the Indian doors to imported goods of that class. England, on the other

Prospects of Improvement.

hand, went in for long-staple cottons in order to produce high-grade goods. She found these in the United States, and thus gradually closed her doors against the short-staple cottons of India. But that inferior yarns might come to be refused both in India and China seems never to have been contemplated, yet it may now be affirmed that the future prosperity of the Indian cotton industry will turn very largely on whether or not the Indian cultivator can produce cotton superior and cleaner to that presently grown. With better-grade cotton it may in all fairness be said that it can be but a question of time when the Indian mills will claim a steadily increasing proportion of the supply of higher-count goods not only to India but perhaps to the world.

Manufacture of Yarn.

Increase in Production of Higher Counts

Foreign Raw Cotton.

MANUFACTURES.*—*Local Trade in Yarn.—The *PRODUCTION* of yarn by the Indian mills (British and Native) has progressed steadily, but not phenomenally. The outturn (including Native States) in 1895–6 came to 432 million lb.; in 1900–1 it fell to 352 million; in 1902–3 rose to 575 million; in 1904–5 stood at 578 million; and in 1905–6 at 655 million lb., with in addition 25 million lb. produced by the mills located in the Native States. Of the amount for 1904–5, Bombay Presidency claimed as its share 422 million lb., being followed by Bengal with 38 million, Madras, 30 million, the United Provinces, 27 million, the Panjáb, 11 million, and lastly by the Native States with 22½ million lb. Of the total production in 1904–5 about 110 million lb. in the British districts and 4 million in the Native States were in higher counts, that is to say, qualities above 20's. This was about 10 million lb. in excess of 1903–4, and 43 million in excess of 1900–1. One of the most significant features of the modern traffic in Indian cotton manufactures is this increase of the outturn of the higher-count yarn, for which a fair amount of foreign raw cotton is being imported, and recently an increasing local production. In 1904–5, 192,544 cwt. of cotton were obtained from the United Kingdom, Germany, Egypt and the United States, etc., and in 1905–6 this supply stood at 161,476 cwt. The production of counts in 1904–5 was 51 million lb. in excess of that of 1899–1900. Attention has been drawn (in the *Review of Trade*) to the fact that the imports of high-count yarns have been almost in the inverse ratio to the expansion of the exports of Indian-produced yarns of that class (30's and over). By way of contrast with this prosperous Indian industry, it may be pointed out that the weight of twist and yarn imported in 1888–9 was 52½ million lb.; in 1898–9 it stood at 45½ million; in 1903–4 at only 28 million; though it rose again in 1905–6 to 45¾ million lb.

Exports of Indian Yarns.

Yarn worked up.

Indian Yarn.—With regard to the *EXPORTS* of Indian twists and yarns, in 1876–7 these stood at close on 8 million lb., valued at 36¾ lakhs of rupees; in 1903–4, at 252½ million lb., valued at about 9 crores of rupees (£6,000,000); in 1905–6 at 297½ million lb., valued at over 12 crores (£8,000,000); and in 1906–7 at 243½ million lb., valued at 10 crores (£6,931,021). Deducting these exports from the above-mentioned total production of yarn at the Indian mills, in 1903–4 there remained 303½ million lb. *plus* the foreign imports of, say, 28 million lb. of yarns, etc., as the amount to be worked up by the Indian power and hand looms; and in 1905–6 about 357½ million lb. *plus* the foreign imports, viz. 45¾ million lb.

Production.

Piece Goods.—The woven goods produced by the Indian mills came to 95 million lb. in 1899–1900; 117 million lb. in 1902–3; 131 million lb. in 1903–4; 152 million lb. in 1904–5; and 156 million lb. in 1905–6, with in addition 7 million lb. turned out by mills in Native States. The

Grey Unbleached.

White and Coloured. Hosiery.

Exports of Indian Goods.

manufactures are mainly grey unbleached; to be more exact, an average of about 83 per cent. are of that nature (126 million lb. out of the total 156 in 1905-6). The proportion of higher-class goods varies in the different provinces; in 1903-4 Madras showed 64 per cent., the Central Provinces 28 per cent., and Bombay 17 per cent. of their manufactures as white and coloured goods, hosiery, etc. It seems probable that the grey goods represent about four yards to the lb. in weight, so that in 1902-3 approximately 386 million yards of grey goods were produced by the Indian mills, 435 million in 1903-4, 524 million in 1904-5, and 540 million yards in 1905-6; while approximately 80 million yards of coloured, etc., were produced in 1902-3, 100 million in 1903-4, 108 million in 1904-5, and 112 million in 1905-6. The goods turned out at the Indian mills are *GREY*—described as *chadars*, *dhutis* (or *dhotis*), drills, *jaconets*. *madapollams*, *mulls*, printers, shirtings, sheetings (T-cloths). *FINER GOODS*—figured, coloured or miscellaneous goods and hosiery. Although the home market is likely for many years to be of primary importance to the Indian mills, the exports of Indian-woven cotton goods cannot be called unimportant. In 1903-4 the exports were valued at Rs. 1,63,07,648; in 1905-6 at Rs. 2,03,78,124 (= £1,358,541); and in 1906-7, Rs. 1,77,17,086 (= £1,181,139).

Imports, Foreign.

Foreign Trade.—Turning now to the *IMPORTS* from foreign countries —chiefly Great Britain—a traffic which constitutes nearly two-fifths of the whole imports taken by India. The trade in yarns, as already indicated, has declined. The piece goods are referred to the following chief groups:—Grey or Unbleached: White or Bleached: and Coloured, Printed or Dyed. India received in 1903-4, 1,085 million; in 1904-5, 1,210 million; in 1905-6, 1,348 million; and in 1906-7, 1,298 million yards of *GREY* piece goods. In 1903-4, 466 million; in 1904-5, 584 million; in 1905-6, 572 million; and in 1906-7, 494 million yards of *WHITE* goods. In 1903-4, 481 million; in 1904-5, 493 million; in 1905-6, 541 million; and in 1906-7, 524 million yards of *COLOURED* and printed cotton goods. These therefore totalled in 1903-4 to 2,032 million; in 1904-5 to 2,288 million; in 1905-6 to 2,463 million; and in 1906-7, 2,318 million yards; and the re-exports from these were in 1903-4, 66 million; in 1904-5, 63 million; in 1905-6, 67 million; and in 1906-7, 61 million yards, thus leaving in 1903-4, 1,966 million yards available for India; in 1904-5, 2,225 million; in 1905-6, 2,396 million; and in 1906-7, 2,257 million yards.

Value of the Indian Mills.

Adding together the estimates of grey and coloured goods given above as the production of the Indian mills, we obtain the following:—466 millions yards in 1902-3; 535 million in 1903-4; 632 million in 1904-5; and 648 million in 1905-6. Deducting from these the exports to foreign countries, viz. 69 million yards in 1902-3, 75 million in 1903-4, 87 million in 1904-5, and 91 million in 1905-6, we arrive at 397, 460, 545 and 547 million yards respectively available for India; and adding these sums to the total imports also mentioned above, the grand totals become 2,448, 2,426, 2,833, and 3,016 million yards as the net Indian supplies for the years in question. This, in a population of 300 millions, allows each person to get about eight to ten yards per annum. It would thus seem that while the Indian mills are spinning very largely for China and other foreign markets, the looms are far more concerned with the home than any foreign markets. Hence but for the exports of raw cotton and the existence of power-loom mills, the Indian area of cotton cultivation would be reduced

The Future.

to about one-quarter its present extent. That is to say, one-half the total production is exported raw and one-quarter in the form of yarn, thus leaving one-quarter to meet the existing local demands. The great feature of the future may be said to be the extent to which Indian manufactures of piece goods may curtail the imports from foreign countries, just as the production of yarn has most certainly curtailed imports of yarn from foreign countries into India.

[*Cf.* Milburn, *Or. Comm.*, 1813, i., 279–82; Royle, *Cult. and Comm. of Cotton in India*, 1851, 62–81; Medlicott, *Cotton Handbook for Bengal*, 1862; Beaufort, *Indian Cotton Stat.*, 1889; also *India's Trade in Cotton Goods and Yarns*, in *Indust. Quart. Rev.*, 1892; Brooks, *Cotton, etc.*, 1898, 240–354; *Imp. Gaz.* iii., 202–3, 281 2; *Rept. of the Chamber of Comm. Beng.*, 1903; Austin, *Cotton Trade of the United States and the World's Cotton Supply and Trade*, 1900; Watkins, *The Comm. Cotton Crops*, in *U.S. Dept. Agri. Stat. Bull.* 1904, No. 28; 1905, No. 34; *The Cotton Industry, Tariff Comm. Rept.*, June 6, 1905.]

D.E.P., vi., pt. i., 92-4.
Plumbago.

GRAPHITE; Ball, *Man. Econ. Geol. Ind.*, iii., 50–6; Holland, *Mem. Geol. Surv. Ind.*, 1900, xxviii., 126; 1901, xxx., 174; *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. 1, 51. Graphite consists almost entirely of pure carbon with a small proportion of iron. It is known also as Blacklead and Plumbago from its appearance, though lead does not enter into its composition.

Production.

A full account of the various localities where graphite has been found in India is given in the *Dictionary*, but though these are fairly numerous and scattered over a wide area, it is only in the State of Travancore that any progress in graphite mining has been made. Prospecting has also been attempted in the Godavari district, Madras Presidency, and in the Ruby Mines district of Upper Burma. According to Holland, regular returns were not available before 1901, but for the period 1901–3 the following records of production in Travancore are available:—1901, 2,490 tons; 1902, 4,575 tons; 1903, 3,394 tons.

Uses.

Graphite is used chiefly in the manufacture of pencils, crucibles, grate and iron-work polish, as a lubricator for machinery, in electrotyping, in the facings of moulds, etc., etc. In India the native mineral appears to be but occasionally utilised, and then only for polishing pottery.

D.E.P., iv., 177-84.

GREWIA, *Linn.*: *Fl. Br. Ind.*, i., 383–93; Gamble, *Man. Ind. Timbs.*, 1902, 108–12; Duthie, *Fl. Upper Gang. Plain*, 1903, 109–17; Prain, *Beng. Pl.*, i., 281–4; TILIACEÆ. A genus of plants which contains about 60 species, 12 only being trees, the rest shrubs or climbers. Of these 36 are natives of India.

Fibre.

Timber.

Fruits.

The species of ***Grewia*** are of little economic importance apart from the fact that the inner bark of most species yields a FIBRE, used in the manufacture of ropes and sometimes of paper. Some have a tough and close-grained wood, recommended for purposes where elasticity and strength are required. Accordingly the chief articles manufactured of these woods are banghy-poles, bows, axe and spear handles and the like. Dr. Bidie, in an article in *The Fishing Gazette*, 1897 (quoted in *Ind. For.*, 1897, xxiii., 148), remarks that the wood of three species, ***G. oppositifolia***, ***G. tiliæfolia*** and ***G. vestita***, should make excellent material for fishing-rods. The fruits of many of the species are edible. The most important are:—***G. asiatica***, *Linn.*, the *phalsa*, *shukrí*, *dahmni*; wild in Central and South India, cultivated elsewhere. ***G. elastica***, *Royle*, the *dháman*; indigenous and planted from Hazara and the Panjáb Salt Range to Sikkim at 3,000 to 6,000 feet. ***G. oppositifolia***, *Roxb.*, the *biúl*, *pastuwanne*, etc.; North-West Himalaya, from the Indus to Nepal, ascending to 6,000 feet. ***G. tiliæfolia***, *Vahl.*, the *pharsa*, *khesla*, etc.; Sub-Himalayan tract from the Jumna to Nepal, ascending to 4,000 feet.; Central and South India; Upper Burma; low country of Ceylon. ***G. vestita***, *Wall.*, the *dhamún*, *sealposra*, etc. Indigenous in the Sub-Himalayan tract from Dehra Dun to Assam; according to Gamble, common in *sál* and similar forests. [*Cf. Pharmacog. Ind.*, 1890, i., 238; Dodge, *Useful Fibre Pl. of the World*, 1897, 187; Woodrow, *Gard. in Ind.*, 1899, 189; *Agri. Ledg.*, 1901, No. 9, 212; Firminger, *Man. Gard. Ind.*, 1904, 286.]

D.E.P., iv., 186-8. Niger Seed.

GUIZOTIA ABYSSINICA, *Cass.*; *Fl. Br. Ind.*, iii., 308; Woodrow, *Gard. in Ind.*, 1899, 365; Mollison, *Handbook Ind. Agri.*, 1901, iii., 101-2; *Rec. Bot. Surv. Ind.*, 1902, ii., 91; iii., 229; Prain, *Beng. Plants*, 1903, i., 614; Cooke, *Fl. Pres. Bomb.*, 1904, ii., 66; COMPOSITÆ. Niger Seed and Oil. The *kálá-tíl, surgúja, rámtil, kernani, khurásni, ulisi, valesulú, huchchellu, gurellu*, etc. A native of tropical Africa, but cultivated as an oil-seed here and there in most of the provinces of India.

Cultivation.

It is a *kharif* crop, sown from June to August and harvested in November or December. Rough and rocky laterite or light sandy soil is generally chosen, and the preparation of the land is very simple. Two ploughings before sowing are sufficient, and manure is not necessary. The seed is drilled in rows 11 to 13 inches apart, and 4 to 6 lb. per acre is held to be a sufficient seed rate. It is more commonly grown alone, but is sometimes accompanied by a pulse-crop. In Bengal a considerable portion of land is under this crop, especially in Chota Nagpur Division, but unfortunately the NIGER seed is returned in the *Agricultural Statistics* under the general heading of "Other Oil Seeds," of which there are usually 500,000 acres, with 150,000 of these in Chota Nagpur. The "Others" are over and above linseed, rape, *til*, so that a fair proportion must be niger. In Madras linseed and *til* (**Sesamum**) are separately returned, but a much larger area than both these put together is usually devoted to "Other Oil Seeds." In 1904-5 the "Others" came to 1,018,483 acres, of which 286,509 are in South Arcot; 111,594 in Anantapur; 92,461 in Cuddapah; 84,810 in Bellary; 71,351 in Karnul; 56,730 in Trichinopoly; 51,909 in Tanjore; and 47,215 in North Arcot, with lesser areas in the other districts. It is impossible to discover the exact proportions of these areas devoted to niger, but they must be considerable. In the United Provinces the acreage of "Other Oil Seeds" was in 1904-5, 113,731, and in the Central Provinces the corresponding figure was 314,716, of both of which a certain proportion would have been niger seed. Bombay is the only province that appears to give separate returns for the acreage of this oil seed. In 1905-6 (according to the *Season and Crop Report*) the total land used for it was 169,863 acres, of which Nasik had 68,940; Poona 22,843; Ahmednagar 14,764; Satara 16,026; Bijapur 7,960; and Ratnagiri 7,147 acres, etc. Rice (*Mysore Gaz.*, 1897, i., 123) gives an account of the niger seed in the various districts of Mysore, which the reader should consult.

Harvest.

When the crop is ripe it is cut near the root and stacked for eight days. It is then exposed for two or three days in the sun, then the seed beaten out with a stick and separated from fragments of the plant by a fan. The greater part is sold to the oil-makers for expression of the oil, the yield of which is about 35 per cent. of the weight of the seed. But the seed dries quickly and in England yields only about 16 gallons of oil per quarter of seed, while rape seed yields 20 gallons. The oil is pale yellow or orange in colour with little odour and sweet taste, more limpid than rape oil, with a specific gravity of 0·924 to 0·928. In its drying properties it ranks between cotton and linseed oil. For making paints, lubricating and lighting, this oil is useful, and in many parts of India is employed in cookery and for anointing the body: it is also frequently used as an adulterant for more valuable oils. It is said to be useful in cases of fracture and dislocation of bones among cattle. The oil-cake is highly appreciated in some parts of the country as a cattle food. In the English market the value of the oil is about 37*s.* per quarter. The production of this oil crop has suffered in recent years, like that of most other oils, through the remarkable expansion of the traffic in kerosene and other mineral oils and the by-products of these illuminants and lubricants. [*Cf.* Basu, *Agri. Lohardaga*, 1890, pt. i., 70; *Pharmcog. Ind.*, 1891, ii., 269-71; *Agri. Ledg.*, 1895, No. 24, 502; Hurst, *Lubricat. Oils, Fats, etc.*, 1896, 199; *Agri. Ledg.*, 1896, No. 28, 280; 1899. No. 12, 121, 144; 1901, 364; *Settl. Rept. Betul Dist. Cent. Prov.*, 1901, 31; Wright and Mitchell, *Oils, Fats, etc.*, 1903, 497; *Imp. Inst. Tech. Repts.*, 1903, 128; *Agri. Ledg.*, 1903, No. 7, 171; Hanausek, *Micro. Tech. Prod* (Winton and Barber, transl.), 375.]

Yield of Oil.

Uses.

Oil-cake.

D.E.P., iii., 104-8. Gutta-percha.

GUTTA-PERCHA.—Since Gutta-percha can hardly be characterised as an Indian product, it will be dealt with here very briefly. It is the commercial name for the inspissated milky sap of several plants of which nearly all (or at least all the important ones) belong to the natural

Different Qualities.

order SAPOTACEÆ. The word "gutta-percha" is of Malayan origin: it signifies the gum or *gutta* or *getah* of the tree known as *percha*: according to some writers *percha* is also the ancient name of Sumatra, so that *getah-percha* would denote the *gutta* of Sumatra. And the true gum is to-day almost exclusively a Malayan product. As it reaches the market gutta-percha is, however, largely adulterated. There are high- and low-priced qualities as well as substances that more or less resemble gutta-percha, but which are adulterants rather than grades of *guttah*. The present article deals with both the pure gutta-percha and its substitutes.

Appearance in Europe.

Uses

Oxidises.

Gutta-percha first definitely appeared in Europe in 1845, and the discovery soon thereafter of its varied utilisations caused an immense demand. Dr. W. Montgomerie read a paper on it before the Society of Arts, London, from which date it became a regular article of trade. It is extensively employed in coating telegraphic cables, owing to its being a perfect insulator, while it is able to withstand in a remarkable degree exposure to varying atmospheric conditions. It keeps good for ten years, if exposed to the open air: 20 years, if protected in tubes; but 20 years, when submerged, have no appreciable effect upon it. Under the action of light, heat and air it slowly oxidises, becomes converted into a brittle resin soluble in hot alcohol. Chemically gutta-percha is almost identical with india-rubber (which see, pp. 647–60). It differs physically, being tough and inelastic. Since the date gutta-percha was made known to Europe perhaps no substance has developed more rapidly, and with india-rubber its uses may be said to be so many and so important as to make these two substances perfectly indispensable to commerce.

Imports into United Kingdom.

Trade.—The immense demand has caused an extended inquiry all over the globe with the view of expanding the area of supply or of discovering useful substitutes. During the past seven years the imports of the United Kingdom alone have been:—1900, 126,059 cwt., £1,685,568; 1901, 88,438 cwt., £1,382,646; 1902, 83,889 cwt., £1,150,902; 1903, 46,411 cwt., £587,712; 1904, 27,288 cwt., £288,535; 1905, 45,434 cwt., £361,475; 1906, 53,271 cwt., £489,280. Of these quantities the Straits Settlements supplied from one-half to three-fourths of the total, but it would seem as if the supply from the Straits was decreasing while that from Venezuela, from British Guiana and from the Netherlands was expanding. It must not, however, be forgotten that a fairly large proportion of these imports are in gutta-percha substitutes, chiefly *Balata*. Burn-Murdoch (*Ind. For.*, 1905, xxxi., 309–20) has contributed useful particulars regarding the extraction, purification, properties, prices and traffic in gutta-percha, also a statement of the exports from Singapore from 1886 to 1903.

[*Cf.* Solly, *Observ. on the Prep. Caoutchouc*, in *Journ. Roy. As. Soc.*, 1840, ii., art. 2, 9 13; James Collins, *Journ. Soc. Arts*, 1885, xxxiii., 784; Burck, *Orig. Bot. de la Gutta-percha*, *Ann. Jard. Bot. Buitz.*, 1885, 1–80; Ferguson, *India-rubber and Gutta-percha*, 1887; Planchon, *Produits des Sapotées*, 1888; Jackson, *Comm. Bot. 19th Cent.*, 1890, 27; *Kew Bull.*, 1891, 231–9; Chapel, *Le Caoutchouc et la Gutta-Percha*, 1892; Heuzé, *Les. Pl. Indust.*, 1895, iv., 285–7; *Ind. For.*, 1894, xx., 225–6; 1898, xxiv., 384–5; Oback, *Gutta Percha, Cantor Lect.* (delivered before Soc. Arts), 1897; Collett, *Études sur la Gutta-Percha Commerciale*, 1902; Jumelle, *Les Pl. à Caoutchouc et à Gutta*, 1898; 1903, 445–523; Lecomte, *Les Arbres à Gutta-Percha*, 1899; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 281, etc., etc; Grélot, *Orig. Bot. des Caoutchoucs et Gutta-Percha*, 1899; Ridley, *Gutta Percha*, *Ann. Bot. Gdns. Singapore*, 1899; Semler, *Trop. Agrik.*, 1900, ii., 724–6; Hill, *Rept. For. Admin. Fed. Malay States*, 1900; *Cat. des Pl. Econ. pour les Colon.*, *L'Hort. Colon.*, 1900, 28–30; Manson, *Burmese Rubber-yielding Pl.*, in *Ind. For.*, 1901, xxvii., 75–96; Warburg, *Les*

Pl. á Caoutchouc et leur Culture, 1902; *Études Coloniales*, June 1902; *Rept. Govt. Bot. Gdns. Penang*, 1902; *Imp. Inst. Bull.*, 1903, No. 1; Romburgh, *Les Pl. Caoutchouc et Gutta-percha*, 1903; *Bull. Straits and Fed. Malay States*, 1903, ii., 226, 312, 367; Gamble, *Gutta Percha Trees of the Malay Peninsula, Kew Bull.*, 1907, 109–21; Tschirch, *Die Harze und die Harzbehälter*, 1906, ii., 893–988; *Kew Mus. Guide*, 1907, 138–9.]

A feature of the gutta-percha trade in which India is much interested is the possibility of some method being discovered by which the milky juices of certain abundant plants might be transformed into useful substitutes. The following may be given as the gutta-percha-yielding plants, as also those that it would seem desirable should in future be experimented with as gutta substitutes:—

Achras Sapota, *Linn.*: SAPOTACEÆ. The Sapota or Sapodilla tree. Is largely cultivated in Bengal for its fruit; yields the Mexican Chicle-gum. [*Cf. Journ. Agri.-Hort. Soc. Ind.*, 1844, iii., 147; Jumelle, *l.c.*, 1903, 521–3.] **D.E.P., i., 80.**

Alstonia scholaris, *R. Br.* (see p. 60); APOCYNACEÆ. The *chatwan*; is believed to be the source of *guttapulei* of Singapore. Hooper (*Rept. Labor. Ind. Mus.*, 1905–6, 29) found the latex to contain 45·1 insol., 41·8 resin and 13·1 ash. [*Cf.* Manson, *l.c.* 82.]

Bassia Mottleyana, *De Vriese*: SAPOTACEÆ. A tree of Malacca and Borneo known as the *kotian*. The milk of this tree is regarded as an inferior quality of gutta-percha. Hooper (*l.c.*, 1905–6, 27) says three samples of the milk of ***B. latifolia*** from Hoshangabad showed on the average 48·9 gutta, 38·8 resin and 12·3 per cent. ash. It was light grey, plastic, but the yield per tree small. A sample from Tinnevelly of ***B. longifolia*** afforded 22·6 gutta, 62·7 resin and 14·7 per cent. ash (see pp. 116–20).

Calotropis gigantea and **C. procera,** *R. Br.* (see pp. 205–6); ASCLEPIADEÆ. The *madar* or *akanda*, abundant bushes all over India, have often been suggested as capable of affording a limitless quantity of milky sap. Whether that could be utilised profitably has not been definitely ascertained. Over the greater part of the Upper, Western and Central Provinces of India they cover many thousand square miles of waste land, and the utilisation of that herbage would be of infinite value to the people. [*Cf.* Manson, *l.c.* 87.]

Euphorbia neriifolia, *Linn.*: EUPHORBIACEÆ (see p. 530).

E. Royleana, *Boiss.* (see p. 531).

E. Tirucalli, *Linn.* (see p. 531).

E. trigona, *Haworth*—the *katti-mandu*. This shrub yields the cement *kattimandu*, often spoken of in connection with South India and the Deccan. It was specially recommended by Sir Walter Elliot in 1851.

Mimusops Kauki, *Linn.*; *Fl. Br. Ind.*, iii., 549; SAPOTACEÆ. Is closely allied to if distinct from ***M. Balata***, *Gaertn., f.*—a tree native in Guiana, Honduras and Brazil which affords a gum that is one of the best substitutes for gutta-percha (Jumelle, *l.c.*, 1903, 493–517). No effort appears to have been made to discover whether any of the Indian species might similarly be of value. Other species are ***M. Elengi***, *Linn.*—the Deccan to Malay Peninsula; ***M. Roxburghiana***, *Wight*—South India; and ***M. hexandra***, *Roxb.*—Deccan and Ceylon. But Gamble (*l.c.* 117) says that neither ***M. Elengi*** nor ***M. Kauki*** are in India known to yield gutta-percha. [*Cf.* Manson, *l.c.* 78.] **D.E.P., v., 252–3.**

Palaquium ellipticum, *Engl.*, *Pflanzenr.*, iv., i., 135; *Bassia elliptica*, *Dalz.*; *Dichopsis elliptica*, *Benth.*; *Fl. Br. Ind.*, iii., 542; *Palaquium*, *Brandis*, *Ind. Trees*, 424-5; Manson, *l.c.* 77; Jumelle, *l.c.*, 1903 457–85; SAPOTACEÆ. This is' the *pauchoti*, *pauchonta*, *kat illupei*, *pala illupei*, etc. A large tree of the Western Ghats from N. Kanara southwards. It affords an inferior grade of gutta-percha, which is collected by tapping the living trees. Gamble adds, "but although this substance can be utilised for waterproofing and cement it is not a complete substitute for the proper article." **D.E.P., iii., 102–3.**

P. Gutta, *Burck*, in *Ann. Jard. Buitz.*, 1885, v., 40; *Dichopsis Gutta*, *Benth. & Hook., f.*, in *Gen. Pl.*, ii., 658; Gamble, *l.c.* 113–21. A tree of the Straits Settlements and Malay Archipelago, where it is known as *taban merah* (in Perak), *niato balam tembaga* (or *abang*) in Sumatra, and is the source of the finer grades of the gutta-percha of commerce. But there would appear to be many qualities of the gutta obtained from this plant, some of which are apparently the produce of distinct varieties, others the results of different methods of preparation, and **D.E.P., iii., 103–4.**

still others indicate varying degrees of adulteration. For example the *taban merah* (according to Burn-Murdoch—the most recent writer) is ***P. oblongifolium***; *taban chaier* is ***Palaquium sp.***: *taban puteh* is ***P. pustulatum*** and *taban baik* is ***P. sp.*** The *taban puteh* is much inferior to the others. On the other hand, while ***P. oblongifolium***, *Burck*, is but a variety of ***P. Gutta***, still by certain writers it is held to be a distinct species and to yield the *taban sutra* of Perak,

Yield.

New Meth

Gamble (*Man. Ind. Timbs.*, 445) says, "The method of collection, usually employed by the Natives of the Malay Peninsula, is very simple but very wasteful. The tree is felled, and either the bark is stripped off altogether or rings are cut at intervals of about a foot. The sap that oozes out is then collected, put in a pot and boiled with a little water, which prevents its hardening afterwards when exposed to the air. It is then run into moulds. The trees usually chosen are those of about thirty to thirty-five years old, and each tree gives 2 to 3 lb. of gutta. Such a system is naturally a wasteful one, and if regularly continued without any arrangements for reproduction would probably lead to the exhaustion of the supply, so that it is satisfactory that French experts are said to have discovered that the gutta-percha can be obtained from the leaves without felling the tree. However this may be, there is little doubt of the value of the product, and that if it is to be regularly produced the tree must be grown in plantation and systematically worked."

P. polyanthum, *Engl.*, *Pflanzenr.*, iv., i., 135; *Isonandra polyantha, Kurz; Dischopsis polyantha, Benth. & Hook.*, *Gen. Pl.*, ii., 658. A moderate-sized tree of Cachar, Chittagong, Arakan and Pegu. This is the *tali*, *sill-kurta*, *thainban*, etc. Kurz says it yields a good quality of gutta-percha and in large quantity. [*Cf. P. obovatum*, King and Gamble, in Hooper, *Rept. Labor. Ind. Mus.*, 1905–6, 27.]

D.E.P., vi., pt. 116.

13. **Payena lucida,** *A. DC*: *Isonandra polyandra*, Wight, *Ic.*, t., 1589; *Fl. Br. Ind.*, iii., 547; Gamble, *Man. Ind. Timbs.*, 449; SAPOTACEÆ. The *dolu-kurta* of Cachar is an evergreen tree of Assam, Tenasserim and the Straits Settlements. ***P. Maingayi***, *Clarke*, a tree of Penang and Malacca. Both these trees afford gutta-percha; the last mentioned, according to Maingay, abounds in that substance.

Burmese Gutta-percha.

P. Leerii, *Burck*, *Rapport Gutta*, 1884; also *Orig. Bot. de la Gutta-percha*, in *Ann. Jard. Bot. Buitz.*, 1885, v., 56, pl. viii.; *P. Leerii*, *Engler*, *Pflanzenr.*, 1889, iv., pt. i., 133, with plate. Kurz rightly transferred *Kertophorus Leerii, Hassk.*, to ***Payena*** (*Journ. As. Soc. Beng.*, 1871, xl., 69), but his Burmese plant is apparently a different species from that of Malacca, Sumatra, Borneo, Banka and Amboina, to which the name ***P. Leerii*** strictly speaking belongs. Kurz accordingly would seem to have desired to correct his mistake when (in *Journ. As. Soc. Beng.*, xlvi, 230) he subsequently gave the Mergui plant the name ***P. paralleloneura***, *Kurz* Hooper found that the Burmese plant contains 59·9 per cent. gutta and 39·6 per cent resin. ***P. Leerii*** proper yields the *sundek* of Perak and the *niato balam baringin* (or *soendi*) of Sumatra—a trade quality of gutta-percha. [*Cf.* Jumelle, *l.c.*, 1903, 486–92; Hooper, *Rept. Labor. Ind. Mus.*, 1905–6, 27–8; Mason, *l.c.* 78.]

H

D.E.P., iv., 219–20. Indian Sarsaparilla.

HEMIDESMUS INDICUS, *Br.*: *Fl. Br. Ind.*, iv., 5; Prain, *Beng. Plants*, 1903, ii., 686; Cooke, *Fl. Pres. Bomb.*, 1904, ii., 146; ASCLEPIADEÆ. Indian (or country) Sarsaparilla; *anantamúl* (*anantvel*), *magrabu*, *sugandí pálá*, *nannari*, *uparsára*; *sárivá* (Sanskr.). A climbing plant of North India, from Banda to Oudh and Sikkim, and southward to Travancore and Ceylon.

Medicine.

The root has long been employed in Native medicine. Garcia de Orta (1563, *Coll.*, xlii.; also in Ball, *Proc. Roy. Ir. Acad.*, 1890, 3rd. ser., i., 656) speaks of a thorny climber which resembles the pomegranate, from the wood, bark and root of which a drug is obtained. Ball regards that passage as possibly denoting ***Hemidesmus***, but is it not rather ***Smilax***? The root is supposed to possess properties allied to those of sarsaparilla, and from 1864 has been officinal in the British Pharmacopœia. It is prescribed usually in the form of syrup and is demulcent, alterative and diuretic. Sometimes the whole plant is pounded and a *congee* made with rice, or an infusion prepared of the dried leaves. In Indian commerce *anantamúl* is found in the form of little bundles, which consist of the entire roots of one or more plants, tied up with a portion of the stem. *Anantamúl* costs 6 to 8 annas per lb., and in Europe appears to sell at 1*s.* 6*d.* to 2*s.* per lb. [*Cf. Pharmacog. Ind.*, 1891, ii., 446-9; De Silva, *Indig. Food Prod., Trop., Agrist.*, 1891-2, xi., 520-1; Waring, *Baz. Med.*, 1897, 72-3; Dutt, *Mat. Med. Hind.*, 1900, 195-6; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 124, 153; *Rec. Bot. Surv Ind.* (many passages); White and Humphrey, *Pharmacop.*, 1901, 224.]

HIBISCUS, *Medik.*: *Fl. Br. Ind.*, i., 334-44; Cooke, *Fl. Pres. Bomb.*, 1901, ii., 104-14; Duthie, *Fl. Upper Gang. Plain*, 1903, 87-93; Prain, *Beng. Plants*, i., 262-9; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 221-2; Malvaceæ. A genus of herbs, shrubs or trees, which embraces about 150 species. Some 33 are indigenous to India and several others have been introduced, and are now cultivated widely. Many are of considerable economic value, one an important vegetable, and another produces a fibre that is extensively used as a substitute both for hemp and jute.

D.E.P., iv., 228-48.

Musk Mallow.

H. Abelmoschus, *Linn.*; *Rec. Bot. Surv. Ind.*, iii., 178. The Musk Mallow, *mushk-dáná, kalkastari, kasturi-bhendi, latá kasturiká*, etc. A herbaceous bush, common throughout the hotter parts of India. It yields a fibre which occupies a high place among those of the jute type. The seeds afford an odorous principle employed in perfumery as a substitute for musk. In European trade they are known as *Grains d'Ambrette*. By the Natives of Northern India they are employed medicinally. Their value varies from about 4*d.* to 1*s.* per lb. [*Cf. Pharmacog. Ind.*, 1890, i., 209-10; *Agri. Ledg.*, 1896, No. 6, 29-31; 1898, No. 15, 505; Mukerji, *Handbook Ind. Agri.*, 1901, 329-30; Schimmel & Co., *Semi.-Ann. Rept.*, Oct. 1902, 9.]

Perfumery.
Price.

H. ficulneus, *Linn.*; *Rec. Bot. Surv. Ind.*, iii., 28, 178. The *ban dhenras, jangli bhindi, kapasiya, dula*, etc. A prickly herbaceous annual, indigenous in the hotter parts of India, from the Panjáb and Bengal to South India and Ceylon. The stem yields a long, glossy, white and strong fibre, useful for twine and light cordage.

Fibre.

Shoe Flower.

H. rosa-sinensis, *Linn.*; Woodrow, *Man. of Gard.*, 1899, 179; Firminger, *Man. Gard. Ind.* (ed. Cameron), 651; *Rec. Bot. Surv. Ind.*, ii., 40, 84; iii., 179. The Shoe Flower, *jásút, juwa, joba, jásavanda*, etc. An ornamental shrub, native of China, but found in most gardens in the plains of India. The bark yields a fibre. The flowers are said to produce a purple dye, and are also used in Native medicine. The roots are employed in Mysore in certain cattle diseases (*Journ. Bomb. Nat. Hist. Soc.*, 1892-3, vii., 512-5).

Fibre.
Dye.

Rozelle.

H. Sabdariffa, *Linn.*; Woodrow, *l.c.* 183; *Rec. Bot. Surv. Ind.*, ii., 40, 84; iii., 28, 179; Firminger, *l.c.* 288. The Rozelle or Red Sorrel of the West Indies, *mesta, patwa, lál ambári, kempu*, etc. A small elegant shrub, widely cultivated throughout the hotter parts of India and Ceylon. The seeds are sown about the end of May, and the plants put out in the ground at a distance of 4 feet from each other. The gathering may be made in November or December in Bengal, but rather earlier in the upper provinces. It seems to thrive best in the damp climate of Lower India and cannot be cultivated on the hills.

Seasons.

The stems yield a strong, silky fibre, the Rozelle Hemp of commerce, obtained by retting the twigs when in flower. The seeds are used in medicine, and have demulcent, diuretic and tonic properties. The fruit, or rather fleshy calyx, is a valuable antiscorbutic, largely eaten in the form of jellies, chutnies and other preserves. The leaves are eaten as salad and in Native curries. [*Cf. Pharmacog. Ind.*, i., 212; Dodge, *Useful Fibre Plants of the World*, 1897, 196; *Imp. Inst. Tech. Repts.*, 1903, 96.]

Fibre.
Medicine.
Jelly.

H. tiliaceus, *Linn.*; Gamble, *Man. Ind. Timbs.*, 1902, 87; *Rec. Bot. Surv. Ind.*, ii., 177, 245, 247, etc.; iii., 179. The *bola, baniá, belli-pata, chelwa, thinban*, etc. A small tree or bush of the sea-coast forests and long tidal rivers all round India, Burma and Ceylon. It yields a fibre of fair quality, which can be readily separated and does not easily rot under water. In Bengal it is used for making rough ropes, in the Sundribans for cordage, and in Ceylon for mats. Gamble remarks that it ought to be useful for paper. Manson (*Ind. For.*, 1905, xxxi., 347-50) gives an account of experiments which have recently been made in Burma with this fibre as a jute substitute. He considers it would probably fetch about £12 per ton, if sent to market in the condition that jute usually

Fibre.
Paper.
Jute Substitute.

appears, though fibre collected in the Toungoo district of Burma and prepared by Mr. Le Fevre is said to have realised as much as £35 per ton in England. Timber. The wood is used only for fuel, and occasionally for hut-building (see **Mats and Matting**, p. 776). [*Cf.* Yates, *Text. Antiq.*, 1843, 304–6; *Text. Journ.*, Oct. 1890; Dodge, *l.c.* 197.]

Deccan Hemp.

H. cannabinus, *Linn.;* Roxburgh, *Trans. Soc. Arts.*, 1804, 382; 1806, 152; also *Coromandel Pl.*, ii., 190; *Rec. Bot. Surv. Ind.*, i., 90, 194; ii., 40, 84; iii., 179; Sprague, in *Kew Bull.*, 1908. Deccan Hemp, kanoff, ambari hemp, *ambári, ambadi, pulu, mesta pát, dare kudrum, pátsan, sheria, pundi, gogu, sujjádo*, etc. A small herbaceous shrub, indigenous in Africa and introduced into India, now cultivated extensively for its fibre.

Cultivation. The cultivation, both as a crop and as a hedge plant, is largely carried on in Bombay (especially the Deccan and Karnátak), the Central Provinces and Madras. Elsewhere to a much smaller extent—Bengal, chiefly Chota Nagpur; also here and there in the United Provinces and the Panjáb. Distribution. The Bombay statistical returns for 1905–6 show an area of 83,109 acres, with 16 acres in Sind, and an average of about 90,000 acres annually. Rocky and laterite soils which are not suitable for jute are well adapted for the cultivation of *ambari.* It grows best on the alluvial soils of North Gujarat, but does also very well in medium black soils. It is usually grown as a mere sprinkling among other crops, and the tillage is the same as that of the crop with which it is associated, especially *bajra* and *juar.* Season. In October–November the plants should be uprooted. Fibre. Full-grown plants which have ripened their seed furnish stronger fibre than if cut while in flower. Retting. The small bundles of stalks, when dry, are tied into large bundles and steeped in water for some ten days. If the fibre is separated in the cold weather, longer steeping is required. When removed the bark and fibre readily peal off in strips from the root upwards. The strips are then beaten with a stick and threshed in water till the clean fibre is separated. Properties. It is bright and glossy, but coarse and harsh. The length is 5 to 10 feet, and the breaking strain has been variously stated at 115 to 190 lb. Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 83) gives interesting particulars of the microscopic structure of this fibre.

The Deccan hemp is spoken of as similar to jute, but very much superior. In India a coarse sackcloth is made from it, though its chief utilisation is for ropes and cordage. Ropes and Cordage. Canva Coarse canvas is also manufactured from it, and in Bengal it is employed for all purposes for which jute is in demand, but being more durable it is used for fishing-nets and paper manufacture. *Ambari* hemp is stated to be worth about 8 lb. per rupee, but no statistics regarding the extent of the trade are available.

A few years ago a fibre appeared on the London market under the name of Bimlipatam jute, which there seems little doubt was Deccan hemp. Still more recently a new fibre from Rio de Janeiro has been much advertised under the name of Canhamo, and this has been shown by Sprague to be obtained from an allied species, ***H. radiatus,*** *Cav.* (*Fl. Br. Ind.*, i., 335). Thus for commercial purposes both the Bimlipatam jute and the Canhamo hemp may be accepted as possessing the same properties as the fibre of ***H. cannabinus.***

Bimlipatam Jute. The demand for Bimlipatam jute is stated to be yearly increasing, and in 1903–4 the exports to London amounted in value to two lakhs of rupees. On the London market it is worth from £11 to £12 12*s.* 6*d.* per ton.

Dunstan's chemical investigations into the properties of this fibre, published in the *Imperial Institute Technical Reports*, as also the further particulars afforded in *The Agricultural Ledger*, will be found useful and interesting. Apparently the samples of Bimlipatam jute were found of lower value than the best Bengal jute. In the subsequent investigations into this fibre it was found to be prepared on an extensive scale in a factory at Chittavalsa in Vizagapatam, as also exported from Bengal to some extent under the name of *mesta pát*. Comparing a sample of true jute with an authenticated sample of Deccan hemp and a good average specimen of Bimlipatam jute, it was found that the percentage of cellulose was nearly the same in all three. The last two were superior to ordinary jute in the smaller loss in mercerising and the larger increase in weight on nitration. The reports therefore conclude that Bimlipatam jute (*i.e.* Deccan hemp) is deserving of attention.

Oil.

The seeds yield a clear and limpid oil, and have been sent to England as an OIL-SEED. They are used in Poona as a cattle food, and the leaves are eaten as a VEGETABLE.

[*Cf.* Jacob. Bontius, in Piso, *Ind. Utri. re Nat. et Med.*, 1658, 113; Milburn, *Or. Comm.*, 1813, ii., 210; Wissett, *Treatise on Hemp*, 23; *Pharmacog. Ind.*, i., 213–5; Basu, *Agri Lohardaga*, 1870, 73; *Kew Bull.*, 1891, 204; 1898 (add. ser., ii.), 9, 11; *Text. Journ.*, Oct. 1893, 12–3; *Rept. Ind. Hemp Drugs Comm.*, 1894, i., 80; iii., 107; *Agri. Ledg.*, 1896, No. 11, 84–5; No. 37, 393; 1903, No. 11, 239–44; Dodge, *l.c.* 192; Mukerji, *Handbook Ind. Agri.*, 1901, 304–6; Mollison, *Textbook Ind. Agri.*, 1901, iii., 227–8; *Imp. Inst. Tech. Repts.*, 1903, 69–71, 86–8; Joret, *Les. Pl. dans L'Antiq.*, etc., 1904, ii., 276; *Capital*, June 22, 1905, 1142; July 6, 1905, 8; *Ann. Rept. Agri. Dept.* (all provinces); *Board of Trade Journ.*, Sept. 7, 1905 (the fibro Canhamo of Rio de Janeiro).

Lady's Fingers, or Ochro.

H. esculentus, *Linn.*; *Rec. Bot. Surv. Ind.*, ii., 84; iii., 28, 178. The Edible Hibiscus, Lady's Fingers; *ochro* or *okra*, of the West Indies, *bhindi*, *dhenras* (or *dheras*), *rámturái*, *bendekai*, *vendaik-kay*, *youn-padi-si*, *tindisa*, etc. A tall herb, cultivated throughout India and naturalised in all tropical countries. De Candolle regards it as of African origin.

Vegetable.

Seasons.

It is largely cultivated by the Natives of India as a garden crop for the sake of its FRUIT. It should be sown from April to June in nurseries, and transplanted when about 3 inches high. Weeding should be done regularly all through the period of growth to keep the soil loose and open. As a field crop successful cultivation largely depends on rich manuring of the soil. Two varieties, an early and a late, are grown in Bombay, both being sown in June. The acre rate of seed varies from 5 to 10 lb. and the seed is sown at intervals of about a foot, on ridges three feet apart. The early variety bears fruits from about August to September, while the late does so from the end of September to November.

Cultivation.

Two Varieties.

Early and Late.

In Madras, the early crop is sown in the first week of March and gathered in the first week of July; the late crop is sown in the latter part of July and gathered in towards the end of December. The yield of fruit per acre varies from 5,000 to 6,000 lb. The cost of cultivation is said to average about Rs. 5 per acre, and the profit about Rs. 9. The bast yields a white FIBRE which is long, silky, strong and pliant, and composed of fine individual threads. The breaking strain is 79 pounds dry, and 95 wet. In colour and texture it resembles hemp, and is well adapted for making ropes, twine and sacking, while the residual portions might be utilised for paper-making. There are no statistics of trade in ochro fibre: it is apparently sold only as an adulterant of jute or of

Yield.

Fibre.

Cordage and Rope.

H. cannabinus. Messrs. Ide & Christie, however, have valued samples obtained from Cuba at about £18 to £20 per ton, and state that it might even fetch more with better methods of preparation.

Medicine.
Vegetable.

The mucilage from the FRUITS and SEEDS is used in medicine as a demulcent. The unripe fruit is a favourite vegetable, and the more mature fruit is sliced, then fried and eaten in curry. In European cookery its mucilaginous property is taken advantage of in the thickening of soups, etc.

[*Cf. Pharmacog. Ind.*, i., 210-2; Duncan, *Dyes and Dyeing in Assam*, 1896, 27; *Agri. Ledg.*, 1896, No. 28, 276; 1898, No. 8, 287; Dodge, *l.c.* 194; *Imp. Inst. Journ.*, March 1898, 77; *Kew Bull.*, 1898 (add. ser., ii.), 6; Blackman, *Fibres of the Hawaiian Islands*, 1903, 51.]

D.E.P., iii., 55-63, 458-61. Hides and Skins.

HIDES, SKINS, LEATHER and the Manufactures therefrom.—The term "*Hides*" denotes commercially the raw, dressed or tanned skins of full-grown cows, bullocks, buffaloes and horses, etc., while "*Skins*" is applied to those of calves, sheep, goats, deer and other wild animals. The term "*Fur*" is used for ornamental skins, with the hair or wool attached.

Furs.

ief Kinds.

It may, perhaps, be as well to dispose at once of the least important group, namely, the "*Furs*." In addition to the skins of Deer and Antelopes, there are returned under "Furs" (*D.E.P.*, iii., 458) some 70 different fancy or ornamental skins that are occasionally met with in trade. The following are some of the more important (mentioned in alphabetical sequence):—***Cynælurus jubatus***, the Hunting Leopard; ***Felis pardus***, the Leopard or Panther; ***F. tigris***, the Tiger; ***F. uncia***, the Snow Leopard; ***Mustela***, two species, the Martens; ***Putorius erminea***, the Ermine or Stoat; ***Sciurus***, the Squirrels; ***Vulpes***, the Foxes; and ***Ursus***, the Bears; etc. It would seem that in India some of the smaller skins, such as dog-skins, snake and lizard skins, mole-skins, frog-skins and the like are utterly neglected, a consequence very possibly of the climate and the defective methods of curing presently practised.

Trade.

Stock.

RAW HIDES AND SKINS.—Supply.—Under **Live Stock** (pp. 732-52) will be found mention of the chief wild and domestic species and races of animals, the skins of which appear under **Hides and Skins**. It is not necessary to enumerate these again, but it may be useful to state once more that the live stock of India cannot be far short of a grand total of 220 millions, of which perhaps 40 per cent. die or are slaughtered annually. The annual average exports to foreign countries at all events were, for the five years ending 1903-4, Hides (raw and tanned) 12½ millions; Skins (raw and tanned) 37 millions, or 23 per cent. of the estimated total stock. But these returns take no cognisance of the hides and skins used up in India nor of the animals that die or are killed, but of which the hides and skins are not preserved.

Annual Supply.
Exports.

Local Trade.

Total Transactions.—It would not be far from correct to affirm that India's local manufactures in skins and leather are as valuable as her foreign trade in these commodities (raw and manufactured). In 1876-7 the total of the declared values of the imports and exports, taken together, was Rs. 3,13,77,912 (or say £2,091,860); in 1902-3 the corresponding figure was Rs. 9,27,48,853 (or say £6,183,257); and in 1903-4 the total traffic came (less the re-exports) to Rs. 9,71,04,548 (or say £6,500,000). If the idea of the internal trade being approximately as valuable as the foreign can be accepted as fairly correct, then during 1903-4 the total turnover of the industries here dealt with (exports *plus* consumption) would have been close on a valuation of £13,000,000. And later figures for 1906-7 show a considerable expansion, viz. to a total (imports and exports, less re-exports) of Rs. 15,94,66,392 (or £10,631,093), and thus of an estimated total traffic of over twenty-one millions sterling.

Traders.

Two Kinds of Hides.

Cattle-poisoning.

Widespread Suffering.

Famine.

Difficulty to obtain Capital.

Fluctuations.—But there are a few aspects of importance that had better be here indicated. For example, the trade in hides and skins, as also the craft in leather manufacture, are in the hands either of Muhammadans or of low-caste Hindus. They are, therefore, participated in by a comparatively small community. So again the workers in skins, hides and leather are in Northern India collectively designated *chirmfarosh*. Then there are two main classes of hides and skins :—*hallali* (slaughtered), *murdari* (dead). The former come from the slaughter-houses of the cities, the latter from the country. The *chumars* (the special caste of skinners) wander about all over the country, and make it their business to skin dead cattle. In seasons of scarcity and famine they reap a rich harvest, but it is often affirmed that they are unscrupulous and, when they do not obtain a sufficient supply, that they are not averse to systematically poisoning cattle. With them, in fact, cattle-poisoning is held to be a profession, and to have attained the position of a high art (see **Abrus**, p. 1). Moreover, it is believed that a large proportion of the cattle that perish in India die from preventable causes, such as neglect, drought and murrain. The loss to the country of a large percentage of its cattle far outweighs the total value of the traffic in skins and hides, so that the increasing exports in these articles are only too frequently the most certain indication of widespread suffering and loss. The traffic in hides and skins is accordingly subject to great fluctuations, concomitant with the vicissitudes of the seasons. The famine in Western India, during the years of 1899–1901, caused the traffic to become abnormally high, especially in untanned hides, but, due to the war in South Africa, the prices were at the same time preserved. The exports for each of those years were nearly double the normal traffic, but the demand was, nevertheless, brisk. The difficulty to procure capital—an ever-present cause of obstruction to all manufacturing enterprise in India—is doubly true of the leather trades. Religious objection assigns it a position of degradation and neglect. It became accordingly a monopoly within a restricted community, and thus not only suffers from want of capital but from the loss of invigorating competition and popular interest and favour.

Foreign Trade.—The exports to foreign countries from the chief seaports of India are drawn from the provinces by rail, road and river, as also coastwise by sea. These may be analysed as follows :—

Local Trade.

Calcutta Supply.

Madras Supply.

Railborne, etc. — Unfortunately a difficulty is at once presented, viz. the railborne and the coastwise transactions are recorded in cwt. It is thus next to impossible to obtain a factor by which to reduce these to numbers of hides as in the returns of foreign trade, since the goods vary so greatly according to species of animal, size and condition, nature of curing or tanning pursued, etc., etc. The figures as they stand are, however, relatively of value :—During 1906–7 the railways of India carried 2,517,787 cwt. of hides and skins (raw and tanned), the bulk being raw. Of that large amount 1,126,302 cwt. were conveyed to CALCUTTA and were drawn—from Bengal Province, 350,953 cwt. ; from the United Provinces, 354,804 cwt ; from the Panjáb, 103,855 cwt. ; from the Central Provinces and Berar, 57,056 cwt. ; from Madras, 13,974 cwt. ; from E. Bengal and Assam, 232,036 cwt. ; from Rajputana and Central India, 7,623 cwt. ; and from Bombay, 4,816 cwt. The next most important receiving centres are the MADRAS PORTS, which, in the year in question, drew 520,856 cwt., namely from the Madras Presidency, 330,512 cwt. ; Mysore, 38,398 cwt. ; the Nizam's Territory, 44,951 cwt. ; Bombay, 56,901 cwt. ; Central Provinces, Bomba Suppl.

Kar.chi Supply.

Pro
Pro

20,705 cwt.; Panjáb, 19,289 cwt.; and from the United Provinces, 5,441 cwt. MADRAS PRESIDENCY is third in importance with 217,674 cwt., derived chiefly from Mysore, 77,677 cwt.; from its own port towns, 61,434 cwt. from Bombay (5,518 cwt.); from the Nizam's Territory (29,968 cwt.) BOMBAY PORT takes the fourth position with a supply of 149,048 cwt., derived chiefly from its own Presidency, 68,823 cwt.; Panjáb, 28,765 cwt.; United Provinces, 23,419 cwt.; Central Provinces, 13,272 cwt.; Madras, 5,462 cwt. Then comes KARACHI with 139,107 cwt., derived mainly from the Panjáb, 100,404 cwt.; Sind, 37,385 cwt.; and from the United Provinces, 842 cwt. Lastly the PANJÁB with a total supply of 113,973 cwt., derived chiefly from Rajputana and Central India, 32,978 cwt.; and from the United Provinces, 58,782 cwt. Looking at these figures from the point of view of EXPORTS, the Bengal Province supplies 357,794 cwt.: the United Provinces 464,376 cwt.; Madras 368,127 cwt.; the Panjáb 296,576 cwt.; Bombay 171,746 cwt.; Mysore 117,866 cwt.; Rajputana and Central India 118,613 cwt.; Central Provinces and Berar 122,774 cwt.; the Nizam's Territory 86,183 cwt.; Sind 54,559 cwt.; and E. Bengal and Assam 234,810 cwt. Thus, so far as the foreign trade is concerned, the supplies come mainly from Bengal and the United Provinces. Cawnpore is the great emporium of leather production in India, and the supplies of hides and skins procured by the tanneries of that town must be very largely drawn from local supplies, seeing that the imports are comparatively unimportant. This fact necessarily raises the United Provinces into the position of greatest importance in the hide trade.

Impo

Coastwise.—Turning now to the coastwise transactions, it is ascertained that the total IMPORTS of raw hides do not normally exceed 25 to 30 thousand cwt., valued at 10½ lakhs of rupees; of raw skins about 15 thousand cwt., valued at 7½ lakhs of rupees; and of dressed and tanned hides and skins about 6½ thousand cwt., valued at 6 lakhs of rupees.

Exports Raw.

Mainly from Calcutta.

Very largely to Germany.

Prices.

Exports.—In the *Review of the Trade of India* for 1904–5 it is shown that, according to the declared values, the prices of hides rose steadily during the preceding four years, the average price for 1904–5 being 11·4 per cent. in excess of that for the previous year. The corresponding price of skins, on the other hand, fell 13·1 per cent. The number of raw hides and skins exported collectively came to 31,606,246, valued at Rs. 7,05,35,585—the shares being 8,722,520 hides and 22,883,726 skins. The value of the raw hides exported from Calcutta was 84·6 per cent. of the total trade. They were consigned to the Continent mainly, Germany taking 144⅖ lakhs; Italy 66 lakhs; Austria-Hungary 51⅗ lakhs; and Spain 22¾ lakhs. This left 23 lakhs consigned to the United Kingdom, and 40⅘ lakhs to the United States. Calcutta also contributes 75·6 per cent. of the total value of the foreign exports in dried and pickled skins. About the same percentage (in value) of the foreign exports is usually drawn from India by the United States. Of the balance, France claimed 29½ lakhs, and the United Kingdom 25¼ lakhs. The demand in France seems to be increasing. The later *Review* for 1905–6 states that the price of hides continued to rise, the average value per cwt. increasing from Rs. 52–4–8 in 1904–5 to Rs. 55–7–0; while that of skins continued to fall, viz. from Rs. 91–1–6 per cwt. in 1904–5 to Rs. 90–7–1 per cwt. The number of hides and skins exported in 1906–7 collectively came to 39,806,281—the shares being 12,917,227 hides and 26,889,054 skins.

Exports Tanned and Dressed.

Traffic to Burma.

TANNED HIDES AND SKINS.—The most significant feature of the coastwise returns, abundantly confirmed by most statistical statements of the Indian trade in hides and skins, may be said to be the fact that Madras is by far the most important centre for dressed skins, and that Burma is the chief coastwise market for them. Recently, however, Bengal has begun to participate largely in this Burmese supply. After Burma, Bombay affords the next most important local outlet for Madras

Madras Production.

dressed skins. And this position of importance held by the Madras Presidency in the traffic in dressed and tanned skins and hides is still further borne out by a study of the foreign trade. During 1904–5 Madras furnished 91 per cent. of the dressed hides and 73 per cent. of the dressed skins, Bombay following with a fair proportion of the balance. The United States of America have hitherto been the most important market for Madras dressed skins. But within the past few years an unhappy new manifestation has appeared, namely a decline in the demand for Indian dressed skins. The export traffic in dressed goods has recently, in fact, fallen back, and the demand for Bengal raw skins advanced considerably. This is presumed to be a direct consequence of the cheaper and more efficient methods of tanning (especially that known as the chrome process) now largely practised in the United States. It points to the urgent necessity for Indian manufacturers to advance with the times or face the total loss of their trade. The tanner who pursues crude methods and continues to employ defective appliances can no more hold his own against the cheapening process of scientific progression than the hand-loom cotton weaver can stem the tide of steam-power prosperity.

America—Chief Foreign Market.

A Change in Character of Exports.

Progress Essential.

Decline in Traffic.

Exports.—The decline in the traffic in tanned hides and skins, established within recent years, calls pointedly for serious consideration. The so-called tanning of India, given to the hides and skins exported, was, and is at its best, so imperfect and unsatisfactory that retanning in the countries to which consigned was essential. But however crude it may be, the business is by no means an unimportant one, nor one for which an effort should not be made to save it from complete annihilation. In 1900–1 the exports of tanned hides were valued at Rs. 1,46,80,048, and of skins at Rs. 3,02,61,805, or collectively Rs. 4,49,41,853 (close on three million pounds sterling). The next year, 1901–2, the collective exports of tanned hides and skins were valued at Rs. 2,65,40,461 ; in 1902–3 they were Rs. 2,89,81,866 ; in 1903–4, Rs. 3,09,88,759 ; in 1904–5, Rs. 2,85,17,173, or approximately one-half the value of the traffic five years previously. Commenting on this somewhat significant state of affairs, Mr. J. E. O'Conor wrote, " This transference of the trade from tanned to untanned skins is likely to proceed in an accelerated degree, to the great loss and detriment of the trade in the Madras Presidency. But it must not hastily be concluded that in itself the contraction of this industry is a subject for regret. If the industry had been established on a sound economic basis, it would not and could not have suffered, for all the natural conditions are in its favour, including cheap and abundant supplies on the spot of skins and tanning substances and cheap labour. These advantages, however, were not effectively utilised, in consequence of the absence of capital, for tanning is essentially an industry in which the possession of large resources counts for much." " The position, however, may be rectified without difficulty if capital is forthcoming ; and if it is desired to prove that tanning is a profitable industry, it may be observed that where it has been undertaken in accordance with sound principle, as in the leading tanning establishments in Cawnpore and Bombay, it has been an extremely profitable and expanding business " (*Anglo-Ind. Review*, April 1903). The returns for 1905–6 show, however, that in the severe fluctuations to which the traffic is ever subject, the pendulum has once more begun to swing forward. The ex-

Past Records.

Transference of the Trade.

Want of Capital.

Improvement in Trade.

ports recorded manifest a great improvement in tanned hides, amounting to an increase of 63·7 per cent. in quantity and 87·6 per cent. in value on the figures for 1904–5. The actual value of the hides exported in 1905–6 amounted to Rs. 1,54,80,070, and of the skins to Rs. 2,11,04,250, giving a total of Rs. 3,65,84,320; and in 1906–7, hides Rs. 1,72,96,337, and skins Rs. 2,72,16,204, or Rs. 4,45,12,541.

D.E.P., iv.,248–51, 605–15. Leather.

LEATHER AND LEATHER MANUFACTURES.—Internal Industries. —Although the objection to taking life is held very strongly by Buddhists and to a less extent by Hindus, it has not seriously opposed the growth of a trade in leather and leather manufactures. From the most ancient times in India, furs, skins, and leather have been used, and apparently to much greater extent than is the case to-day. Speaking of the frontier of India, Stein (*Ancient Khotan,* 1907, 345 *et seq.*) describes in great detail the ancient records, correspondence, etc., written on leather and wood, which he discovered during the exploration of the Niya site, and some of which bear the date of the 3rd century A.D. "The finish given," he says, "to the leather of these ancient documents indicates extensive practice in the preparation of the material." Leather, when once prepared, was thus not objected to by the early Buddhists of Khotan, any more than are the leather straps of the sacred books used by the orthodox Brahmans of to-day, in Kashmir and India generally. Book-binding in leather Stein regards as dating back to the Hindu period of Kashmir, and thus long anterior to the Muhammadan conquest. Many of the stucco statuary and fresco paintings of Ancient Khotan show personages riding on horses and camels, the saddles and trappings of which differ but little from those in use to-day; and the riders are often depicted wearing high boots of black leather richly embroidered in gold and silk. These circumstances may thus be accepted as indicative of an ancient knowledge in leather.

Ancient Knowledg

Horse Trappi

It is not contemplated to deal here in detail with the contrivances and materials of leather manufacture. The various provincial Governments of India have recently had prepared a series of publications entitled *Monographs on the Tanning and Working in Leather.* These, so far as they go, are admirable publications, and will be found to afford much useful information regarding the manufacture and utilisation of leather in India.

Leather.

Leather.—It may very truly be said that no large industry has changed more rapidly and completely than that of leather. Every axiom of the craft and even the reputation of leather itself has changed completely, for artificial leather is now a regular commodity. But speaking figuratively, India may be said to be many years behind the times. From being an industry in which time and capital had to be locked up almost indefinitely, tanning may now be spoken of as characterised by a rapidity of production and a turnover hardly equalled by any other branch of manufacturing enterprise. From being essentially a craft for manual labour, every stage in the tanning of leather and the preparation from it of the most artistically finished boots and shoes are accomplished by complex and intricate machinery. And what is even more significant, the countries that have responded most energetically to the discoveries of science and of mechanical skill have usurped or are usurping the leather trade of the world. Instead of it being now found necessary to retain hides and skins for a protracted period, subject to the slow action of some vegetable tanning material, rapid chemical methods (by mineral salts,

Advan Science

or even aided by electricity) have been called into existence and accepted with avidity by the trade. Electricity.

Chrome Process.—By the chrome process, for example, superior leather may be produced from the strongest buffalo hides in seven days, from cow-hide in twenty-four hours, and from sheep and goat skins in six to eight hours; and these operations formerly took thirty days, or as much even as eighteen months. There are two methods of chrome tanning, viz. by one or by two vats. After the required submersion the hides or skins are removed from the drums and piled up on a table for twenty-four hours, so as to allow the tanning liquors to drain off slowly, the while completing the tanning process. After this the felts are well washed in several changes of water and are then put into a solution of borax and water to neutralise any trace of acid. The neutralisation of the acid is a point that demands careful consideration. After further washing the leather is now ready to be dyed or fat liquored, according to the purpose for which intended.

Chrome Process.

Acid. Neutralisation.

A point of great moment is the circumstance that once dried, chrome leather can never again be sufficiently wetted to allow of treatment, so that the complete preparation for its final purpose must be undertaken almost immediately the hides or skins are taken from the vats. The half process pursued by many Madras tanners it would seem may have to be abandoned if they propose in the future to adopt chrome tanning. But the new process is neither expensive nor difficult, and with such improvements accomplished it is not difficult to understand why salted hides and skins are preferred to the more expensive half-tanned goods of Indian former trade. While the discoveries here briefly indicated and others too numerous to mention have proved of supreme moment to the leather trade of the rest of the world, the Native tanners of India have stood still and seen their interests being frittered away. Protracted immersion has for many years past been admitted as impossible in India. The superiority of European leather over that of India was accordingly freely acknowledged as a direct consequence of that circumstance. But now that scientific and effectual rapid methods have been designed and freely accepted in other countries, India alone stands aloof and speculates as to the obligation of Government to aid a decaying industry. With the few European manufacturers alone have the discoveries of the past twenty years assumed the position of guiding and controlling influences in internal reform and commercial advancement.

Peculiarity of Chrome Leather.

Preference for Salted Hides and Skins.

Advantages of New Process.

Imports of Leather.—But in spite of general backwardness the leather produced by some of the tanneries, especially those under European management, is in certain respects fully equal to the best imported article and for rough wear the boots turned out by the Cawnpore factories are even superior (especially when the price is taken into consideration) to the corresponding imported goods. This view would seem to be supported by the fact that the imports of unwrought leather do not appear to be advancing at a rate commensurate with those of manufactured leathern goods. Thus the imports in 1900-1 stood at Rs. 5,55,911; in 1901-2 at Rs. 4,18,348; in 1902-3 at Rs. 6,61,480; in 1903-4 at Rs. 3,81,192; in 1904-5 at Rs. 3,72,167; in 1905-6 at Rs. 4,24,596; and in 1906-7, Rs. 5,04,407. If to these figures be added the value of the imports of saddlery and other goods (except boots and shoes), the grand totals became in 1903-4, Rs. 26,19,633; in 1905-6, Rs. 30,60,820; and in 1906-7, Rs. 32,58,681.

Imports.

Unwrought Leather.

Leathern Goods.

Tanneries.

Dressed Skins.

Cawnpore.

Indian Tanneries.—Turning now to the statistics of tanneries in India, it may be said that in 1893 there were 44 tanneries that gave employment to 3,804 persons. Steadily these would appear to have increased until in 1902–3 it was ascertained that there were 202 tanneries and 6,200 employees. Of these tanneries, however, 183 were small concerns located in the Madras Presidency and concerned chiefly in the dressing of skins. In 1903–4 and subsequent years all the smaller works (those that gave employment to less than 25 persons) were excluded from consideration, and 43 tanneries were returned giving employment to 7,907 persons. In 1904–5 35 were returned, employing 5,981 persons. Of these 32 were in Madras (excluding the small skin-curing works). The tanneries of North India are six in number located in Cawnpore; four in Calcutta; three in Bombay; and one in Rajputana. The Cawnpore tanneries are by far the most important in all India. They produce superior leather, which is conveyed across the country and worked up by the local boot and shoe makers, saddlers, etc. The Cawnpore factories also turn out very superior boots and shoes, leather trunks, saddlery, etc., for which a large and growing market exists.

Local Tanning.

Effete Methods

Indigenous Methods.—But here and there, in every town and village of India, skins may be seen tanned by certain classes of people. It is no uncommon sight to find the skins of animals filled with tanning materials and left suspended from the boughs of trees or from the beams of the verandahs of the dwelling houses, until the desired change has been accomplished in the skin. In other instances crude vats, each containing one or two skins, may be discovered near the leather workers' houses. The provincial monographs will be found to contain highly instructive photographs, not only of such vats, but also descriptive details of many of the methods and contrivances of leather-curing practised in India. The tanned skins and hides produced in India by the indigenous tanneries are traded in all over the country and used up by the village workers. But the distinctly inferior nature of the leather so used may be illustrated by the fact that the articles produced rarely fetch much more than one-fourth the values of the corresponding articles made of imported or Cawnpore (European factory) leather. So again, Indian leather, owing to its low textile strength, is unsuited for belting purposes or any necessity where strength is essential.

Tanning Materials.

Tanning Materials.—India possesses an extensive series of very excellent tanning materials such as ACACIA pods and bark (see pp. 6–7); CUTCH (see pp. 9–13); INDIAN SUMACH (see p. 913); the TANNER'S CASSIA (see pp. 289–90); the MANGROVES (see pp. 98, 293); MYROBALANS (see pp. 1073–6); and many others. By these and such-like materials and by various methods and contrivances, hides and skins are extensively cured, tanned and curried and the leather worked up, in response to an immense though purely local demand. [*Cf. Agri. Ledg.*, 1896, No. 9; Hooper, *Rept. on Tanning Extracts*, pub. by Inspector-General of Forests, Feb. 1898; *Tanning-Producing Substances*, Assist. Agri. Chemist to Govt. of India, 1901; Hooper, *Ind. Tanning Materials*, in *Agri. Ledg.*, 1902, No. 1, also numerous analyses in the Annual Reports of the Indian Museum (Economic) Laboratory.]

Concluding Observations.—In technical works it is said there are three chief methods of tanning:—(1) with infusion of bark or other vegetable materials; (2) with mineral salts; (3) with tanning oils. After being tanned the skins are subjected to further treatment and are finally spoken of as "dressed."

Various Qualities.

Anthrax.

Hides are tanned principally for sole, belting and harness leather; calf-skins for uppers of boots (light leather) and bookbinding; sheepskins afford a variety of leathers; goat skins are glove skins, although lamb skins and deer skins afford good substitutes in glove-making. The thickest sole leathers are made from the cattle of the less cultivated countries, since artificial protection seems to tend to render the skin thinner. The cattle of the River Plate are the chief source of the heavy hides or *butts*. Castration gives a more uniform hide, and these are much preferred. Hides of diseased animals are nearly always inferior, and moreover dangerous, as there would seem reason for believing that anthrax may be conveyed by imperfectly cured hides. Similarly the sheep most prized and most carefully produced as fleece-yielders afford very inferior skins. Hides may be preserved by being salted on the fleshy side or by being simply passed through a solution of arsenic and dried in the shade. This is the modern practice in India, especially at the yards of the large and important shippers.

Boots and Shoes.

Imports.

Local Production.

Centres of Production.

Cawnpore.

Exports.

BOOT AND SHOE TRADE.—The IMPORTS of boots and shoes have for some years been increasing rapidly. In 1886–7 the supply was valued at Rs.11,31,258; in 1903–4 at Rs. 27,93,249; in 1905–6 at Rs. 34,45,418; and 1906–7, Rs. 29,08,093. One of the most significant features of this trade is the expansion of American supply, which even in India has begun to be felt. The Indian market is thus one of growing importance, and this circumstance manifests the possibilities of the local industry, already well organised. Every village and town has its shoemakers. In the cities whole streets are often devoted to them, and one of the most surprising features of the trade is the very large number of Chinamen engaged in it. Native shoes are often elaborately embroidered and even jewelled. The places most famed for artistic shoes and leather work generally are in BENGAL—Cuttack, Patna and Saran. In the UNITED PROVINCES—Rampur, Lucknow, Agra, Jhansi and Saharanpur. In the PANJAB—Kohat, Rawalpindi, Peshawar, Dera Ghazi Khan and Hoshiarpur. In the CENTRAL PROVINCES—Chanda. In RAJPUTANA—Jaipur and Bikanir. In BOMBAY—Surat, Ahmedabad, Poona, Ratnagiri and Hyderabad (Sind). In SOUTH INDIA—Raichur, Salem, Trichinopoly, Madras and Mysore. These are the chief centres in the Native trade, but, as already said, Cawnpore stands out pre-eminently as the commercial centre of the modern trade (European style) in boots, shoes, saddlery, trunks, etc. Lastly, it may be added that for the past ten years or so India has begun to export boots and shoes. In 1898–9 this traffic was valued at Rs.3,52,027; in 1902–3 at Rs.10,59,052; in 1905–6 at Rs. 4,88,640; and in 1906–7, Rs. 4,68,491. These exports go from Calcutta and Bombay and are consigned mainly to Natal, Cape Colony, Mauritius and Egypt, with smaller quantities to England, Russia, etc. Indian (or, to be more correct, Cawnpore) ammunition boots are now well known in trade.

Art Manufactory.

"Frontier Belts."

Embroidered Sheets.

Stamped Leather.

Artistic Manufactures.—Belts, powder-flasks, saddlery, saddle-cloths, etc., etc., are extensively produced all over the country, and in some cases the goods turned out are of superior quality and highly artistic. The "Frontier Belts" of Peshawar, Bannu, Kohat and Quetta are well known and in much demand over a large portion of India. *Sambar* leather is also richly embroidered, and in the form of sheets, table-cloths, etc., is extensively used. The localities best known for the production of these are Gorakhpur in Oudh and Chanda in the Central Provinces. In the Karnul district of Madras leather mats are quaintly painted, and in many parts of Rajputana and Bombay leather is admirably stamped and engraved in bookbinding. The most noted centres for this art are Alwar and Ahmedabad. In Gujarat an industry has long existed in carving rhinoceros-hide shields. In some cases, instead of being carved the hide is so cured as to become almost transparent and of a pale amber colour. [*Cf. Ind. Art at Delhi*, 1903, 199–205; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 90–5; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 367–95; Perkin, *Yellow Colouring Matter in Tan. Mat.*, *Chem. Soc.*, 1900, 423–32; *Monographs*:—Grant, *Leather Indust. Pb.*, 1891–2; Martin, *Tanning and Working in Leather, Bombay*, 1903; Walton, *U. Prov.*, 1903; Hadi, *Dyes and Dyeing in U. Prov.*, 1896, 58–61;

Chandra, *Beng.*, 1904; Trench, *C. Prov.*, 1904; Chatterton, *Madras*, 1904; Colston, *Burma*, 1904; Josef Jettmar, *Practice and Theory of Leather Manuf.* (Phelan and Hall, transl.), Jan. 1905; Lawrence, *Valley of Kashmir*, 1895, 379; *Journ. Chem. Indust.* (numerous articles), 1896, xv., to 1905, xxiv.; *Board of Trade Journ.*, Oct. 1905; Arkill, *Journ. Agri. Dept. Victoria*, 1902, i., 196-9; *Leather Trades Review*; *Boot and Shoe Journ.*; *Textile Journ.*, 1898, 84; also 1902; *Hide and Leather Tech. Journ.*, since 1903 (these and other such technical publications have been consulted).]

D.E.P., iv., 255-9. Conessi Bark.

HOLARRHENA ANTIDYSENTERICA, *Wall.*; *Fl. Br. Ind.*, iii., 644; Gamble, *Man. Ind. Timbs.*, 484-5; Prain, *Beng. Pl.*, ii., 674; Cooke, *Fl. Pres. Bomb.*, 1904, ii., 133. APOCYNACEÆ. Kurchi or Conessi Bark, *kara, kurra, kuda, karchi, kúar, kogar, kachri, dhowda, dowla, repali, pala, lettok kyi*, etc., etc. A small deciduous tree, found throughout India and Burma, ascending the lower Himalaya to 3,500 feet, and to a similar altitude on the hills of South India. It is an associate of *sál* (***Shorea robusta***) in Northern and Central India, and of *eng* (***Dipterocarpus tuberculatus***) in Burma.

Medicine.

Both bark and seed of this plant are among the most important MEDICINES of the Hindu Materia Medica. Garcia de Orta, who wrote in 1563 (*Coll.*, xxviii.; reprinted, in Clusius, *Hist. Exot. Pl.*, 1605, 227-8; also in Ball, *Proc. Roy. Ir. Acad.* (ser. 3), i., 412), speaks of this as being called by the Portuguese *herba Malabarica* owing to its great merit in the treatment of dysentery having been made known through the people of Malabar. In *The Bower Manuscript* (Hoernle, transl.) repeated mention is made of the drug (*kutaja* or *vatsaka*, the bark, and *kalinga*, the seeds), as also of ***Picrorhiza Kurroa*** (*kutuka, rohini, katukarohini*, etc.), both of which seem to be regarded as having very similar properties. The preparation, generally in the form of a solid or liquid extract or of a decoction, is astringent, anti-dysenteric and anthelmintic. The bark of an allied plant, ***Wrightia tinctoria*** (see pp. 1131-2), has been confused with and substituted for the true *kurchi*, and thus led to the latter having fallen somewhat into disrepute. The bark of ***Wrightia*** may be distinguished from true conessi bark by its darker colour and by its not exfoliating in patches. The seeds yield a fixed OIL, and among the Santals the wood ash is used in dyeing. The WOOD is white and soft, with an average weight of 38 to 40 lb. per cubic foot. It is largely used for carving, especially in Saharanpur and Bijnor districts; in Assam for furniture; in South India for turnery. [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 151; *Pharmacog. Ind.*, ii., 391-8; Woodrow, *Gard. in Ind.*, 1899, 382; Dutt, *Mat. Med. Hind.*, 1900, 192-5; *Yearbook of Pharmacy*, 1897, 152; 1900, 399; *Rept. Cent. Indig. Drugs. Comm.*, 1901, i., 2, 8-9, 11, 71-2, 142-3; *Agri. Ledg.*, 1901, No. 9, 346; 1902, No. 5, 110; Barry, *Legal Med. Ind.*, 1902, 449.]

Oil.
Wood.

D.E.P., iv., 273-84. Barley.

HORDEUM VULGARE. *Linn.*: *Fl. Br. Ind.*, vii., 371-2; Duthie and Fuller, *Field and Garden Crops*, 1882, i., 9-12, t. ii.; Kornicke, *Die Saatgerste*, in *Zeitschrift für das Gesammte Brauwesen*, 1882, v., 113-28, *et seq.*; De Candolle, *Orig. Cult. Plants*, 1884, 367-70; Duthie, *Fodd. Grass. N. Ind.*, 1888, 69-70; Lermer and Holzner, *Beiträge zur Kenntnis der Gerste*, 1888; Lisboa, *Bomb. Grasses, etc.*, 1896, 135-7; Prain, *Beng. Plants*, 1903, ii., 1231; GRAMINEÆ. Barley, *jav, súj, nas, tosa, yurk, thanzatt, satú, barli-arisi, yava*, etc.

Habitat—An annual grass producing many stems from a single grain, and becoming 2 to 3 feet long. It occurs throughout the temperate and extra-tropical regions of the globe, and in India is met with from the plains to altitudes of 14,000 feet above the sea-level.

There are several well-marked varieties, of which the most important are:—*var.* (α) ***hexastichon***, *Aitchs.*; *var.* (β) ***distichon***, *Linn.*; and *var.* (γ) ***nudum***, *Ard.* ***Hexastichon***, or six-rowed barley, is that which is most commonly cultivated in India. The only variety hitherto found wild is *distichon*, which seems to be indigenous to Western Temperate Asia.

Early Knowledge.
Chinese.
Egyptian.
Khotan.
Indrajau.
Sanskrit Names.

History.—Barley is amongst the most ancient of cultivated plants, but as its forms resemble each other very closely in their properties and seem to have had, in all languages, common names, it is not easy to ascertain which variety is referred to by the early writers. Proofs in abundance exist that one or other of the forms has been cultivated since the remotest times. According to Bretschneider, barley is one of the five cereals sown by the Emperor Shen-nung of China, who reigned about 2700 B.C. Theophrastus was acquainted with several forms of barley, and it was an important article of food in the time of Solomon (B.C. 1015). The variety ***hexastichon*** has been found in the earliest Egyptian monuments, as also in the remains of the later dwellings of Switzerland and of Savoy. The six-rowed barley is represented on the medals of Metapontos—a town in South Italy—of date 6th century B.C. The oldest known Indian (or rather Central Asiatic) samples of barley are those collected by Stein at Karadong (*Ancient Khotan*, 1907, 448). The ruins in question had been engulfed by sand about the close of the 8th century A.D. The variety most frequently met with in India is also ***hexastichon.*** Indra is called "the god who ripens barley," and as still manifesting ancient knowledge it may be added that the grain is employed in the ceremonies attending the birth, marriage and death, as also certain sacrificial rites. This idea is also borne out by the antiquity of the Sanskrit name *yava* (*yavaka*), which in the earliest times was a general term for corn or grain, but which with time became restricted to what must have been at least a very important grain—barley; hence have come the modern vernaculars—*jav, jau, Indrajau, jawa*, etc. The grain is also closely associated with the Indian Muhammadans. In the *Ain-i-Akbari* the crop is said to have been one of the most important in Afghanistan and Kashmir, a large part of the revenue in these countries having been obtained from barley by exacting the usual two out of every ten *kherwars* produced.

Cultivation.
Soils.
Ploughing.
Seed-rate.
Irrigation.
Weeding.
Cost of Production.

CULTIVATION.—Barley is a *rabi* crop, sown in October or November, and reaped in March or April. In Bombay it is generally grown alone, occasionally with a sprinkling of rape or mustard, but in many parts it is often mixed with wheat, gram, peas or lentils, while rape, Indian mustard and linseed are commonly sown as borderings. The SOILS on which it thrives best are light and sandy, and, as a rule, not highly manured. The number of PLOUGHINGS before sowing varies, but four would be a fair average. The SEED-RATE runs from about 80 to 120 lb. per acre. It is sown by plough-furrows, the surface of the ground being subsequently levelled and beds for irrigation formed. IRRIGATION, however, may not be necessary, and in districts which enjoy a tolerable certainty of rain it is but rarely resorted to. Little WEEDING is required, the crop being left very much to itself till March–April, when it is REAPED like wheat, tied up in sheaves, and stacked near the homesteads to dry. The preparation for the market is the same as that for wheat. The total COST of growing an acre is variously stated: Mukerji puts it at only Rs. 18–8; Duthie and Fuller, Rs. 20–12; and Mollison gives for Gujarat, Rs. 51–8–0. Huskless barley from Saharanpur is described in the *Kew Bulletin* (1888, 271–3).

Area.

Areas under the Crop.—From the *Agricultural Statistics of British India*, it appears that in recent years far the largest quantity of this cereal is grown in the United Provinces and in Bengal. The Panjáb, North-West Frontier, Ajmer-Merwara, Bombay, the Central Provinces, Sind and Madras follow in the order given. The total area under barley in British India for the year 1905–6 was 7,326,755 acres. Similarly, in the Native States, the area in the same year is said to have been 418,463 acres, chiefly in Jaipur, Alwar, Bharatpur and Gwalior.

Bengal.

Bengal.—The cultivation of barley is mostly restricted to the central and northern districts. It is more especially met with in South Bihar, where it forms one of the cheapest of foods. In North Bihar (Bhagalpur) it is of less importance. The cultivation of barley diminishes south and east, and is practically not grown in Bengal proper nor in Orissa. Though in recent years Bengal stands second as regards the total area under this crop, within the province it is comparatively unimportant, the percentage of the normal area under barley having amounted in 1904–5 to only 2·50. The total barley area in that year was 1,514,700 acres, and the yield 494,243 tons; hence if an average be assumed, these figures would show 6·4 cwt. per acre. In 1906–7 the area was 1,411,100 acres. The chief localities are usually Patna, Bhagalpur, and Chota Nagpur. [*Cf.* Mukerji, *Handbook Ind. Agri.*, 1901, 245–7; Basu, *Agri. Lohardaga*, 1890, ii., 32–3; Banerjei, *Agri. Cuttack*, 1893, 78–9; *Rept. Admin. Beng.*, 1903, 15; *Ind. Planters' Gaz.*, Sept. 19, 1903; Oct. 10, 1903.]

U. Prov.

United Provinces.—These provinces stand first in British India as regards the total area under barley and the annual output. In 1905–6 it amounted to 4,127,936 acres, of which Agra contributed 3,137,104 and Oudh 990,832. The largest areas were in the Gorakhpur, Benares, Lucknow and Allahabad Divisions. Duthie and Fuller estimated the average outturn of unmixed barley at 16 maunds per acre if irrigated, 8 to 11 maunds if unirrigated. [*Cf. Cawnpore Exper. Farm Rept. Dist. Gaz., U. Prov.* (many passages).]

C. Prov. and Berar.

Central Provinces and Berar.—The total area for 1905–6 in these provinces would appear to have been 11,608 acres, and the chief districts Jabbalpur, Damoh, Bilaspur and Chanda. Of Berar, 94 acres have been returned as under this crop.

Rajputana.

Rajputana.—The crop is apparently an important one, especially in Ajmer-Merwara, where, during the ten years ending 1899–1900, it is returned as having occupied 16·1 per cent. of the average cultivated area. [*Cf. Rajputana Gaz., Ajmer-Merwara*, 1904, i., 46.] But of the whole province, in 1904–5, mention is made of a total area of 38,728 acres. In irrigated land it yields an average of about 7·34 cwt. per acre, but in dry crop land the average outturn is given as only 1·46 cwt.

Panjáb and N.-W. Frontier.

Panjáb and North-West Frontier.—The system of cultivation is very similar to that in Bombay and the United Provinces, but the practice of topping an over-leafy crop is said to be common; the crop is generally grown unmixed. The total area for 1905–6 was 1,205,678 acres in the Panjáb and 315,272 acres in the North-West Frontier. The most important localities are usually Ferozpur, Hissar, Gurgáon in the Panjáb; Peshawar, Hazara and Bannu in the North-West Frontier. [*Cf.* Montgomery, *Barley Cult. Pb.*, in *Select. Rec. Finance Comm. Office*, 1885, No. 29; *Rept. Govt. Agri.-Hort. Gard. Lahore*; *Dist. Gaz. Pb.* (many passages).]

Kashmir.

Kashmir.—According to Lawrence (*Valley of Kashmir*, 1895, 341), barley is the most important spring crop, if area alone be considered. It is not, however, of good quality, and no pains are taken in its cultivation. In the higher villages, at an elevation of 7,000 feet, there is a peculiar variety known as *grim*, or Tibet barley. The grain is naked like wheat, and it is said that if cultivated at a lower level it takes on the type of ordinary barley. It is sown in May and June, ripens in August and September. Barley gives on an average 8½ maunds per acre; *grim*, about 4 maunds. [*Cf. Assess. Repts. Baltistan*:—Kaye, *Skardu Tahsil*, 1901, 8–9; Clarke, *Kargil Tahsil*, 1901, 19, 23; also *Skardu Tahsil*, 1901, 20–3.]

Bombay.

Bombay.—Barley is not extensively grown in Bombay. In 1905–6 the total area was only 23,103 acres. In that year Ahmedabad grew 11,330 acres; Kaira 3,448; Satara 4,807; Sholapur 1,284; and Panch Mahals 463. It is generally grown alone, occasionally with a sprinkling of rape or mustard. In parts of Gujarat wheat and barley are grown mixed. As in other provinces, it is a light-soil crop, the sandy loams of Kaira and Ahmedabad district being particularly suitable. Mollison remarks that 1,500 to 1,800 lb. of grain per acre and about a ton of straw are considered a full average yield. [*Cf.* Mollison, *Handbook Ind. Agri.*, 1901, 44–5.]

Madras.

Madras.—Barley is a very unimportant crop. For the year 1905–6 the total area in the Presidency amounted to only 3,280 acres, all in the Nilgiris. In Mysore the total in 1905–6 was 1,338 acres.

Milling.
Food.
Mixed with Wheat.

Milling or Preparing.—The process of cleaning barley for food purposes is generally carried out by pounding in wooden mortars and winnowing, or by beating with a flat board. The grain is then ground into coarse meal from which alone, or mixed with the meal of wheat or gram, *chapattis* are made and baked; or a gruel or pasty mass is made, to which salt is added and the preparation eaten with garlic, onions or chillies. In either of these forms it is a staple article of food among the poorer classes. The grain, thus roughly cleaned and ground, is richer in albuminoids than the more carefully prepared culinary barley of Europe; but at the same time it is more difficult to digest, and is thus partly unsuited for the dietary of dyspeptics or invalids.

Beer.
Fodder.

In various parts of India barley is now largely employed in the preparation of beer or spirituous liquor, and the use of barley in Europe for malting and brewing is well known (see **Malt Liquors**, p. 759; **Vinegar**, p. 1109). Mollison gives an account of the qualities which give barley a special value for these purposes. It is also largely used as a horse and cattle fodder. In some parts of India the crop is cut two or three times when quite young, without marked injury to the final yield of grain. The straw even of ripe barley makes a fairly good fodder when cut up as *bhúsa*, but is inferior to that of wheat. The grain is a good feed both for horses and cattle, either given alone or mixed with gram.

Chemistry.
Medicine.
Malt Extract.

Properties and Uses.—The chemical composition of ordinary husked Indian barley is given by Church as follows:—in 100 parts: water 12·5, albuminoids 11·5, starch 70·0, fat 1·3, fibre 2·6, ash 2·1. The nutrient ratio is here 1 : 6·3 and the nutrient value 84·5. In medicine, barley is demulcent and easily digested, and is much used in the dietary of the sick. Malt extract has become extremely popular both as a nutritive and demulcent, and as a means for rendering other medicines palatable.

Trade.

Trade.—Official trade statistics show the following as the *EXPORTS* from British India in the six years ending March 31, 1907:—1901–2, 54,648 cwt., valued at Rs. 1,80,180; 1902–3, 63,872 cwt., valued at Rs. 2,27,937; 1903–4, 113,120 cwt., valued at Rs. 3,56,421; 1904–5, 376,548 cwt., valued at Rs. 12,68,154; 1905–6, 92,810 cwt., valued at Rs. 3,12,548; and 1906–7, 406,067 cwt., valued at Rs. 12,51,753. There was thus a steady increase till 1904–5, but a sudden decrease in 1905–6. In 1904–5 (the record year) Bombay exported the largest share, viz. 231,037 cwt. (though in the previous year it exported only 25,883 cwt.); Sind 86,070 cwt.; and Bengal 59,307. The relative shares of the exporting centres are, however, subject to great variation. During the same period the *IMPORTS* were:—1900–1,

88,523 cwt., valued at Rs. 3,59,845; 1901-2, 14,495 cwt., valued at Rs. 59,757; 1902-3, 628 cwt., valued at Rs. 2,718; 1903-4, 21,792 cwt., valued at Rs. 85,505; 1904-5, 7,220 cwt., valued at Rs. 28,239; 1905-6, 25,948 cwt., valued at Rs. 92,487; 1906-7, 32,339 cwt., valued at Rs. 1,09,070.

Prices.—The average wholesale price per 10 maunds during 1905 varied in Bengal from Rs. 17·67 in Muzaffarpur to Rs. 19·01, in Patna; in the United Provinces from Rs. 17·6 in Meerut to Rs. 22·47 in Fyzabad; in the Panjáb from Rs. 14·53 in Amritsar to Rs. 20·37 in Delhi.

[*Cf.* Marco Polo, *Travels* (ed. Yule), 1871, i., 150, 153; Fryer, *New Acc. E. Ind. and Pers.* (ed. 1698), 119; Moorcroft, *Travels*, 1820, i., 204, 268, 276; 1824, ii., 384; Bentham, *Rev. of Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 135; Mason, *Burma and Its People* (ed. Theobald), 1883, ii., 96; Church, *Food-Grains of Ind.*, 1886, 99-102; *Kew. Bull.*, 1888, 271-3; *Pharmacog. Ind.*, 1893, iii., 615-8; *Agri. Ledg.*, 1892, No. 1-3; 1893, No. 12, 54; 1899, No. 7, 49; 1901, No. 4, 47; No. 10, 364-5; No. 13, 441; 1902, No. 5, 110; 1903, No. 7, 150, 156, 171-2; 1904, No. 6, 47; *Ind. Gard.*, Dec. 22, 1898, 554; Thorpe, *Dict. Appl. Chem.*, 1898, i., 490-500; Collins, *Agri. Chem.*, 1898, 13, 22; Dutt, *Mat. Med. Hind.*, 1900, 269-70, 324; A. W. and M. W. Blyth, *Food Compos. and Anal.*, 1903, 143-5, 171-2; Joret, *Les Pl. dans L'Antiq., etc.*, 1904, ii., 244, 313; Leach, *Food Inspect. and Anal.*, 1905, 213, 221, 233; Hanausek, *Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 349-52.]

D.E.P., iv., 284-9. Horn and Horn-work.

HORNS, ANTLERS, AND HORN-WORK.—Blanford, *Fa. Br. Ind.* (Mammalia) 1888-91 (respective pages of species below). HORNS and ANTLERS are largely utilied in the manufactures of the world, and in their crude state are fairly extensively exported from India. The traffic is mainly in the hands of the dealers in HIDES and SKINS.

The following animals will be found fully discussed under **Live Stock** (pp. 732-49), and, as they are the chief sources of the horns of Indian commerce, that article should be consulted:—***Bos indicus*** (*l.c.* 483-93), the breeds of the Ox; ***B. bubalus***, the wild and domesticated Buffalo; ***B. grunniens***, the Yak; ***B. frontalis***, the *gayal*; ***B. gaurus***, the Bison; and ***B. sondaicus***, the Banting or Burmese Wild Bull. ***Capra*** (*l.c.* 501-8), the various breeds of Goat; ***C. ægagrus***, the Baluchistan, etc., Wild Goat; ***C. falconeri***, the Markhor; ***C. sibirica***, the Ibex. ***Ovis*** (*l.c.* 493-501), domestic Sheep; ***O. hodgsoni***, the Tibetan Great Sheep; ***O. nahura***, the *bharal*; ***O. poli***, the Great Sheep of the Pamirs; and ***O. vignei***, the *kuch* or Wild Sheep of the Salt Range. Lastly, a small group of transitional animals such as ***Hemitragus jemlaicus*** (*l.c.* 508-12), the *tehr* of the Western Himalaya; ***H. hylocrius***, the Nilgiri Wild Goat. ***Nemorhædus bubalinus*** (*l.c.* 512-5), the Himalayan Goat-antelope; ***N. sumatrensis***, the Burmese Goat-antelope. ***Cemas goral*** (*l.c.* 516-7), the *goral* of the N.W. Himalaya, or Himalayan Chamois. The ***Boselaphus tragocamelus*** (*l.c.* 518-9), or *nilgai* or Blue Bull. ***Tetracerus quadricornis*** (*l.c.* 519-21), the Four-horned Antelope. ***Antilope cervicapra*** (*l.c.* 521-4), the Black Buck. ***Gazella bennetti*** (*l.c.* 526-8), the Indian Gazelle, etc., etc. To that list of BOVIDÆ—Oxen, Sheep, Goats and Antelopes—has to be added the Deer, such as ***Cervulus muntjac*** (*l.c.* 532-4), the Barking Deer. ***Cervus axis*** (*l.c.* 534-51), the Spotted Deer; ***C. cashmirianus***, the Kashmir Stag; ***C. duvauceli***, the *barasingha*; ***C. eldi***, the Manipur Deer or *thameng* of Burma; ***C. porcinus***, the Hog-deer; ***C. unicolor***, the Sambar or Rusa Deer. And ***Rhinoceros unicornis*** (*l.c.* 472-4), the great One-horned Rhinoceros, etc., etc. Such then may be given as an enumeration of animals from which, in India and its mountainous frontiers, horns and antlers are obtained. Commercially, however, the horns might almost be said to be derived from the domesticated oxen—all the others being special or fancy articles, in which there is but a limited traffic.

Classification.—Horns may be grouped as follows:—

I. Those that consist of bone and which possess no true horny matter in their structure.

(*a*) True bone, such as antlers of deer.

(*b*) Epiphyses or separate pieces of bone covered by skin, such as in the horns of the giraffe.

II. Horns that more or less consist of true horny matter.

(*c*) Bone tipped by horn, such as in the horns of the prong-horned antelope.

(*d*) Bone covered or sheathed by true horn, such as in the ox.

(*e*) True horn throughout, such as the nasal horn of the rhinoceros.

True horny matter is formed by a modification of the epidermal tissue (the superficial layers of skin) and consists of an albuminoid material called *keratin*, a substance identical with the chief constituent of wool.

Antlers.

Horns of the *first* group are largely exported from India to England, under the name of deer-horn. The antlers chiefly traded in are those of the spotted deer (30 inches and under) and the *sámbar* (40 inches and under). They are extensively employed in Europe as bone handles for cutlery, umbrellas, sticks, etc. The *second* group are valued on account of the special properties of *keratin*; it is elastic, flexible and tough, and readily softens under heat and allows of the substance being moulded and welded as desired. Long, straight buffalo-horn is valued as a substitute for whalebone, and on this account fetches a higher price than curved horn. Accordingly, the tips are cut off and sold separately. The horns of sheep and goats are whiter and more transparent than those of other animals, and are, therefore, most valued for comb-making, while certain buffalo-horns are in demand for ornamental work. Perhaps one-fifth of the horns imported into England are used up in the comb trade, a small proportion being utilised for fancy work, such as shoe-horns, scoops, drinking-cups and the like. The solid tips, as also the hoofs of cattle (which consist largely of *keratin*), are made into buttons. The long, straight horns are cut into strips softened in a solution of bi-carbonate of soda; the strips being allowed to sweat, are then bevelled and pressed together, when they unite into the strips that are employed in place of whalebone. In Jaipur and elsewhere in India long straight horns have similarly been used from ancient times in the manufacture of bows and arrows.

Horns.

Combs.

Buttons.

Whalebone Substitute.

Trade in Horns and Hornmeal.—The *EXPORTS* of horn of all kinds from India were 71,894 cwt., valued at Rs. 12,80,051, in 1876–7; a decade later the quantity had been reduced by nearly one half, but the value remained the same; a decade still later the exports were 59,804 cwt., valued at Rs. 16,73,241. The traffic is one that fluctuates extremely according to climatic conditions. In times of scarcity and famine the exports increase and the horns decline in value, while in times of plenty the quantity decreases and the value increases. During 1901–2 the exports were 62,944 cwt. and Rs. 13,35,759; in 1902–3, 71,396 cwt. and Rs. 17,05,257; in 1903–4, 48,405 cwt. and Rs. 12,05,798; 1904–5, 61,582 cwt. and Rs. 13,72,375; 1905–6, 73,521 cwt. and Rs. 17,49,944; and in 1906–7, 78,771 cwt. and Rs. 16,91,532. Usually about 50 per cent. of the trade goes from Bombay, and approximately a similar proportion of the total is consigned to the United Kingdom—the shares taken in 1899–1900 having been 45,660 cwt.; in 1903–4, 25,718 cwt.; and in 1906–7, 26,678 cwt. France is the next most important receiving country, having taken in 1899–1900, 25,590 cwt.; in 1903–4, 13,226 cwt.; and in 1906–7, 32,887 cwt. The share contributed by Calcutta is ordinarily little over half that of Bombay. The *IMPORTS* drawn by India from foreign

Exports.

From Bombay.

To United Kingdom.

countries (by sea) are unimportant, in 1903-4 having been only 353 cwt., valued at Rs. 75,041; and in 1905-6, 316 cwt., valued at Rs. 69,318.

Internal Transactions.

The examination of the returns of trade carried by rail and river *reveals the fact that the chief provinces of supply are Bombay*, the United Provinces, Central Provinces, the Panjáb, Bengal and Madras. Official returns of the trade of England and Continental countries distinguish as a rule the traffic in deer horns from that in buffalo, and judged from these it would appear that India is one of the chief countries from which the former are obtained. Indian trade statistics do not separate the two, so that the returns reviewed above are for all grades collectively.

Industries.

Rhinoceros Horn-cup.

Buffalo Horn ware.

Indian Industries.—The chief forms of horn used in the Indian craft (*kangi-sáz*) are buffalo and bison horn, since there are religious objections to the use of cow-horn. A cup made of rhinoceros-horn is much prized by Hindus, but it is too scarce a material to be generally used. Buffalo-horn is by far the most largely employed in India of all horns, but it is the least beautiful. It is made into cups, tumblers, combs, musical instruments, work-boxes, powder-flasks, bows and arrows, *hukka* mouth-pieces, scent-bottles, snuff-boxes, sword, dagger and knife handles, and many other such articles. The centres of the trade are Cuttack, Monghyr, Satkhira (Khulna), Hughli and Serampore in Bengal, where combs, brooches, necklaces, snake bangles and the like are made. Rajputana, Jaipur and Kota are famed for their horn works. Rajkote combs, Baroda spoons, Kathiawar knife-handles, Surat and Ahmedabad veneered boxes and Baroda animal toys of horn are all well known. In Mysore, umbrella-handles, powder-boxes and buttons are made of buffalo-horn, and often richly inlaid with ivory and copper. But it is in Vizagapatam that horn veneered work may be said to have assumed the condition of high-class ware. In Ratnagiri and Savantvadi a fair trade is done in bison-horn work. Aitken (*Agri. Ledg.*, 1897, No. 10) wrote a most interesting account of the industry in the former locality. Perhaps the most instructive feature of that publication may be said to be the method of softening the horn. It is coated with cocoanut-oil and heated before a fire until it becomes sufficiently soft to allow of its being pulled out and moulded into the desired shape.

Vizagap. Boxes.

Bison Horn.

Softened by Cocoanut-oil.

[*Cf.* Royle, *Prod. Res. Ind.*, 4; Lowin, *Wild Races S.E. Ind.*, 306; Mukharji, *Art. Manuf. Ind.*, 148-9, 279-81; Forsyth, *Highlands C. Prov.*, i., 278-9; Hoey, *Monog. Trade and Manuf. N. Ind.*, 130-1; Birdwood, *Ind. Art.*, ii., 218; *Ind. Art. at Delhi*, 1903, 194-8.]

D.E.P., iv., 311-5.

Penny-wort.

HYDROCOTYLE ASIATICA, *Linn.*; *Fl. Br. Ind.*, ii., 669; Cooke, *Fl. Pres. Bomb.*, 1903, i., 562; Duthie, *Fl. Upper Gang. Plain*, 1903, 390-1; UMBELLIFERÆ. The Asiatic Penny-wort, *brahmi*, *bráhmamanduki*, *tholkuri*, *karivana*, *vallárai*, *mandukaparni*. A small herbaceous plant, found throughout India from the Himalaya to Ceylon at altitudes up to 2,000 feet.

Medicine.

The medicinal properties of this plant were known to Sanskrit writers of very remote times, and the early European writers on Indian Materia Medica were also acquainted with the plant. The parts generally employed are the leaves, dried by exposure to the air and ground to a powder. The powder is of a pale green colour and exhales a slight characteristic aroma. It is an alterative, tonic and a local stimulant, said to be efficacious both as an internal and external remedy in ulcerations, eczema, leprosy and other cutaneous affections. The chemistry of the leaves was first investigated by Lepine in 1855, who found they contained oily and resinous constituents, with mucilaginous principles and tannin, to which collectively he gave the name of *vellarin*, a word derived from the Tamil name of the plant. [*Cf.* Christy, *New. Comm. Pl.*, 1878–88, 58–62; *Pharmacog. Ind.*, ii., 107–10; Waring, *Baz. Med. of Ind.*, 1897, 75–6; *Pharm. Journ.*, July 1, 1899, lxiii., 16–7; Dutt, *Mat. Med. Hind.*, 1900, 176; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 14, 62, 146, 179.]

I

D.E.P., iv., 337–82. India-rubber.

Chief Sources.

Caoutchouc.

INDIA-RUBBER, CAOUTCHOUC OR GUM ELASTIC.—Caoutchouc, like gutta-percha, is a vegetable inspissated milk or latex. In both cases the substance consists of a hydrocarbon, forming corpuscle-like bodies floating in a fluid. Gutta-percha becomes soft and plastic in hot water and may be moulded into any desired shape, which it preserves on cooling. Caoutchouc, on the other hand, is not softened by heat, is impervious to water, alcohol and most acids, etc., and retains its elasticity for a considerable period. Gutta-percha is chiefly obtained from trees that belong to the SAPOTACEÆ, while caoutchouc is derived from certain plants which have been placed in three widely different natural orders. These are ***Funtumia***, ***Hancornia***, ***Landolphia*** and ***Willoughbeia*** of APOCYNACEÆ; ***Castilloa*** and ***Ficus*** of URTICACEÆ, and ***Hevea*** and ***Manihot*** of EUPHORBIACEÆ. The plants that afford gutta-percha and india-rubber thus manifest no definite botanical affinity, except that they are mostly natives of tropical countries. In the plant tissue caoutchouc circulates within certain anastomosing vessels which are distributed throughout the middle, or more rarely the inner layer of bark. [*Cf.* Lecomte, *Journ. d'Agri. Trop.*, 1903, xvii., 375.] A far larger number of plants possess milk (and even a caoutchouc-yielding latex) than those generally viewed as the sources of india-rubber. The term caoutchouc is sometimes used synonymously for india-rubber, but it more correctly denotes the pure hydrocarbon isolated from the other materials with which it forms the impure rubber of commerce. Caoutchouc is highly elastic, lighter than water, has neither taste nor smell, is fusible at about 248° F. and inflammable at higher temperatures.

Tapping.

Use of Salt, etc.

Boiling.

Smoking.

Scrap Rubber.

Alum.

Weber's Method.

Methods of Agglutination.—When the bark of plants containing rubber is cut, the milk exudes, and in time hardens on exposure to the air. This agglutination may be hastened by adding salt water, alum or acetic acid to the milk; but these, more especially salt, increase one of its defects, viz. the hygroscopic property by which it becomes moist and sticky, and in consequence they injure it commercially. A favourite but wasteful method is to allow the milk to flow into holes in the ground and to be left there till the water, etc., has drained off. Boiling the milk is the system followed in Lagos, while in the Amazon valley the smoke of a smouldering fire, combined with moderate heat, is the system almost universally pursued with Para rubber. In a few cases the milk is simply allowed to dry as it trickles down the stem. This gives the SCRAP RUBBER of Ceara and a good deal of that of Assam and Penang. The alum (or Penang) process was recognised as being useful for Assam, where the humid atmosphere operates against the drying of the rubber. Dr. C. O. Weber, in a series of articles contributed to *The India-rubber and Gutta-percha Trades Journal* in 1902, also 1904, has stated the facts regarding coagulation briefly as follows:—

1. That the so-called coagulation of rubber by acids or alkalis is

erroneous in that it is only the albumen which is coagulated by these substances, and not the india-rubber itself.

Albumen.

2. That the albumen contained in latex is very harmful in many respects, and that it ought to be as far as possible eliminated from the milk before attempting to agglutinate the rubber.

3. The method he recommends for coagulation is briefly as follows :— First mix the latex with water, at least five times its volume. In cases where the latex is thick, actual boiling water may be used with advantage. In this state it can be easily strained to remove impurities. After this, add formaldehyde in the proportion of 8 oz. to a petroleum barrel ; stir well and let it stand for twenty-four hours, when the rubber will collect on the top and can be lifted out in one mass. In order to remove any traces of albumen that may be suspended, the rubber should next be cut into strips and subjected to a thorough washing upon an ordinary rubber washing-machine. [*Cf.* Weber, *Chem. India-Rubber*, 1902.]

Formaldehyde.

But the use of formaldehyde does not seem to have been the success that Weber anticipated, though his recommendation for cleanliness and repeated washing has been universally accepted. Biffen (*Annals of Botany*, 1898, xii., 165–71) suggested the use of a centrifugal separator. The milk is mixed with 50 per cent. of water, and set revolving for a time. It is then found that the rubber floats on the top in a thick mass. The albuminoids, etc., and all the adulterants are found below. It has next to be admitted that by many recent writers the value of centrifugal force has been denied, and special machinery patented in which the merit claimed is that they do not involve centrifugal action.

Centrifugal Separator.

Indian Planting and Gardening (March 29, 1900) published a letter from Faber that gives particulars of a method of extracting caoutchouc from dry bark, said to have been discovered by a French chemist, M. G. Deiss. This process consists in keeping slices of bark and roots soaked in dilute sulphuric acid while being heated. The woody portions become decomposed and can then be washed out, thus leaving the rubber in a pure state. For other methods of extracting india-rubber by solvents or mechanical processes the reader should consult Gerber's article on that subject. [*Cf. Journ. Soc. Chem. Indust.*, 1902, 414–5 ; *Kew Bull.*, 1898, 177–81 ; Mathieu, *Agri. Bull. Straits and Fed. Mal. States*, 1903, ii., 18–21 ; 1905, iv., 223–4.

Dry-bark Process.

Chemical Composition.

Composition of Rubber.—India-rubber may be said to consist chemically of two substances—an elastic material, on which its merit depends, and a viscid resinous substance readily oxidisable, to which it owes its depreciation. Hence the greater the percentage of resin the less the value of the sample. The property of the elastic substance also varies, and in a marked degree, between that obtained from one genus of plants and that of another, so that every gradation exists from the non-elastic hydrocarbon known as gutta-percha (which see, pp. 625–8) to the finest gum elastic. Caoutchouc yields by dry distillation a mixture of simpler hydrocarbons, called oil of caoutchouc or *caoutchoucin*, which forms an excellent solvent for caoutchouc and other resins.

Caoutchouc. Resin. Empyreumatic Oil.

History.—During the second voyage of Columbus it was noticed that the inhabitants of Hispaniola (Hayti) played with balls made from the gum of a tree. In 1770 Priestly recommended the use of that substance for the purpose of erasing pencil markings, hence the name "rubber." The article was new to Europe, and the proposed utilisation of it excited some interest. It was not, however, until 1820 that the beginning of the modern industry can be traced,

Rubber.

Waterproofing.
Ebonite.
Modern Phases.
Trees and Climbers.

Three years later Mackintosh created the waterproofing trade by dissolving rubber in naphtha. Nelson Goodyear in 1839 vulcanised it, and this rapidly led to the production of ebonite. Rubber and its products may now be spoken of as indispensable to the domestic life and to manufacturing and engineering enterprises of the entire human race. J. G. Baker wrote in 1886 (*Gard. Chron.*, xxv., 363) an interesting article on the production of this all-important substance. Part of the supply, he then wrote, comes from SOUTH AMERICA, shipped from Para and Carthagena, part from SIERRA LEONE, Mozambique and Madagascar, and the remainder from tropical Asia. After exhibiting the botanical and geographical supplies, Baker dealt with the future, and what he then urged regarding cultivation has proved the keynote to present successes. So in the same way Sir George King, while reporting the introduction of ***Landolphia*** into the Botanic Gardens of Calcutta, observed that the exotic rubbers "with the exception of ***Ceara*** are either very large trees or climbers: and although it may pay well to collect rubber from them in their native forests, where they have grown to maturity without cost to the collector, it is quite a different matter when their planting and protection have to be paid for, and their coming to maturity has to be awaited for years." That opinion has since been somewhat modified, though, so far as the interests of the European planters (who are at most temporary residents in the tropics) are concerned, not materially. The plantations established by the Government of India have, however, begun to prove of considerable value, as have also some of those made by private enterprise. Indeed, the experience of the past few years would seem to show that perhaps greater success may attend private enterprise in this direction than was currently believed a few years ago.

Success.
Conditions.
Isoprene.

Conditions of Success.—The whole question of rubber production seems to turn on the cultivation of quick-yielding species, on superior methods of causing and securing the flow of milk, and on the high prices prevailing for carefully prepared rubber. The production of caoutchouc by the spontaneous change of the hydrocarbon *isoprene* is not at present of practical importance. Many of the oxidised-oil products now being manufactured manifest not a few of the properties of rubber and seem destined to relieve the strain for supplies of the natural article, but they have all one serious defect, namely they possess no elasticity. Accordingly, the fear of over-production of natural rubber, most writers think, is at present infinitesimal. [*Cf. Ind. For.*, 1898, xxiv., 187; *Kew Bull.*, 1899, 27; *Journ. Soc. Chem. Indust.*, 1902, xxi., 56; 1904, xxiii., 556.]

Demand.
Twenty Million Trees.

Modern Demand.—The growth of modern demand for rubber may be manifested by the following: the exports from the Amazon valley alone in 1864 came to close on eight million pounds, and thirty years later (1904) they came to sixty-seven million pounds, a quantity that represents the systematic tapping of twenty million trees, and which fetched over thirteen million pounds sterling (see p. 660). In India, Ceylon and the Federated Malay States rubber cultivation is being vigorously prosecuted, and the future seems destined to see a still further expansion in these countries.

Ceylon.
Castilloa.

Asiatic Production.—In Ceylon during 1905 there are believed to have been 40,000 acres devoted to ***Hevea*** and to a lesser extent to ***Castilloa*** rubber trees. The plantations are mostly within the valleys, but some extend up to an altitude of 2,000 to 2,500 feet. It seems an accepted axiom that the higher ***Hevea*** is planted, the slower it will grow and the less the yield. ***Castilloa*** ceases to be profitable in Ceylon at altitudes above 1,500 feet. It has recently been urged, regarding Ceylon, that it might pay to extend plantations of these rubbers into tracts that have to be systematically irrigated. Speaking of South India, Mr. Proudlock, Curator of the Government Gardens on the Nilgiri hills, made an interesting discovery, viz. that ***Castilloa*** trees three or four years old, in the Barliar plantation (2,400 feet), yielded a somewhat gummy substance destitute of the properties of true rubber. Fifteen Season for Tapping. months later these self-same trees yielded a better quality of rubber; hence he concludes that the change from yielding a gummy substance to yielding a true rubber coincides with, or closely follows the period Travancore. when the species first begins to produce ripe seed. In Travancore much interest has been taken by His Highness's Government in the allocation of suitable tracts within the valleys of the State for rubber plantations.

Commercial Rubbers. Biscuit. ***Commercial Rubbers.***—The rubbers of commerce are (*a*) the biscuit and bottle rubbers of South America, such as the Para (the most important) which comes from Brazil, Venezuela, and recently from Ceylon and the Straits. (*b*) Castilloa, such as the Central American rubbers, of which there are certain grades :—Nicaragua, West Indian, Honduras, Mexican, Guatemala, Panama and Peruvian. These appear in BLOCKS, SHEETS or Scrap. SCRAPS. (*c*) The true Ceara is a dry rubber, very elastic, and free from stickiness; it coagulates in tears forming scrap. (*d*) Pernambuco and Mangabeira are coagulated with salt and are accordingly " wet " rubbers. (*e*) Numerous trade forms of African rubber, such as Gambia, Sierra Leone, Lagos, Gold Coast, Congo (ball), Calabar, Cameroon, Batanga, Liberian, etc. (*f*) Mozambique (ball), Sausage (liver), Madagascar (good and fine, also black). (*g*) Asiatic, such as Assam, Rangoon, mostly scrap rubbers formed into cakes, slabs or loaves. (*h*) Javan, Bornean, New Guinea, etc., rubbers (see **Gutta-percha**, p. 626).

[*Cf.* Thomas Bolas, *India-rubber and Gutta-percha Indust.* (six lectures), in *Journ. Soc. Arts*, 1880, 753–813; *India-rubber and Gutta-percha Indust.*, in *Ind. For.*, 1898, xxiv., 111–9; *Rubber*, in *Queensland Agri. Journ.*, 1899, v., 410, etc.; Morris, *Sources of Comm. Rubber, Cantor Lect. in Journ. Soc. Arts*, July 1898, 745–96; Sadebeck, *Die Kulturgew. der Deut. Kolon.*, 1899, 268–81; Wiesner, *Die Rohst. des Pflanzenr.*, 1900, i., 356–89; Semler, *Trop., Agrik.*, 1900, ii., 692–724; Nisbet, *Burma under Brit. Rule and Before*, 1901, i., 439; ii., 87; *Beihefte zum Tropenpfl.*, 1905, vi., 74; *Journ. Soc. Chem. Indust.*, 1882, i., to 1905, xxxii.; *Kew Bull.* (add ser., vii.), 1906; Tschirch, *Die Harze und die Harzbehalter*, 1906, ii, 989–93; Herbert Wright, *Rubber Cult. in Brit. Empire*, 1907; Hemsley, *Kew Bull.*, 1907, 153–6; *The Ceylon Rubber Exhibition*, in *Agri. Journ. Ind.*, 1907, ii., pt. i., 73–80.]

The following, in alphabetical sequence of their scientific names, may be given as a brief statement of the india-rubber yielding plants of the world in which India is presently interested :—

D.E.P., iv., 364–5. Castilloa. **Castilloa elastica,** *Cerv.*; Hemsley, *l.c.* 156; URTICACEÆ. Central American, Panama and Nicaragua Rubber. Torquemada was the first to mention the rubber of Mexico. He gave it the name of *ulé*. Long years after, Cross successfully introduced the plant to the Old World. In 1876 he conveyed live plants to Kew Gardens, and from that supply the plants that first reached Ceylon and finally India were distributed by Sir William Thiselton-Dyer. Willis and Wright (*Handbook Veg. Econ. Prod. Ceylon*, 1901, 41–5) give many useful particulars regarding the experience gained in that country. Mr. W. S. Todd subsequently was successful in having conveyed from Mexico and San Salvador seeds which he germinated in Burma and ultimately sent supplies to Samoa, a fact of some interest, since the seeds of this species are believed to lose their vitality very Two Forms. rapidly. But there are two species of ***Castilloa*** that yield rubber, and comparative studies have not as yet established which is the more preferable for special cultivation. The Indian and Ceylon plant is chiefly ***C. elastica***, the Mexican species, and ***C. Tunu***, that of British Honduras and Costa Rica. This is the *tunu* rubber or *el hule macho* (the mule-rubber), but is not the mule-rubber of Brazil.

Manson (*Ind. For.*, 1901, xxvii., 75–96) furnishes much useful information regarding the India-rubber plants of India. Of this species he remarks that it is cultivated in Mergui under wrong conditions, namely on swampy gound. He Indian Experience. recommends that it should be tried in Tenasserim on hillsides with a western aspect. The plant has been fairly successfully grown on the hills of South India, as, for example, near Calicut and Malabar, as also on the Nilgiri hills (Barliar). Speaking of experience gained in Bangalor, Cameron (*Rept. Govt. Bot. Gard.*, 1902–3, app. ii. and iii.) says this plant is intermediate between Para and Ceara, requiring neither the tropical humidity of the former nor the open and comparatively dry conditions of the latter. It is, in fact, a tree for the coffee zone. He accordingly recommends it for the moist regions of the hills, and Ceara for the plateau of Mysore. [*Cf.* Morris, *Cantor Lect. l.c.* 761–5; *Circ. Roy. Bot. Gard. Ceylon*, 1898, ser. i., 96–104; 1903, 125–9; Cook, *Journ. Agri.-Hort. Soc. Ind.*, 1904, 30–43; *Bull. Imp. Inst.*, 1903, 160–7; 1904, 32–8; *Trop. Agrist.*, 1905, xxv., 160–5, 199–200; *Board of Trade Journ.*, 1905, 134–5; Tschirch, *l.c.* 1008–9; Wright, *Rubber Cult. in Brit. Empire*, 1907, 20–1; Herbert Wright, *Cocoa*, 1907, 78–9; *Rubber Exper. in Bomb.*, in *Agri. Journ. Ind.*, 1907, ii., pt. i., 81; *Kew Bull.*, 1907, 103.

Chonemorpha macrophylla, *G. Don.*; Apocynaceæ. A large climbing shrub met with in North and East Bengal and the moist tropical forests of India generally from Kumaon to Travancore. Recommended as worthy of trial as a new source of rubber, but from experience gained at Buitenzorg the subject does not seem encouraging. [*Cf. Kew Bull.*, 1896, 186; Manson, *l.c.* 4; *Bull. Imp. Inst.*, 1904, 160.] **D.E.P., iv., 343, 362.**

Cryptostegia grandiflora, *R. Br.*; Asclepiadaceæ. An extensive climber, fairly common on the western and southern tracts of India, and is stated to have been repeatedly cultivated with a view to the utilisation of both its milky sap and beautiful fibre. So long ago as 1893 the rubber prepared from it was reported on in England as "hardly equal to Ceara rubber from Brazil, although its general qualities are very encouraging." [*Cf.* R.E.P., *Comm. Circ.*, 1898, No. 2; *Ind. For.*, 1898, xxiv., 429; Dunstan, *Offic. Repts.*, 1903–4; Wright, *l.c.* 28.] **D.E.P., ii., 625; iv., 344.**

Ecdysanthera micrantha, *A. DC.*; Gamble, *Man. Ind. Timbs.*, 488; Apocynaceæ. A large climbing shrub common in the Darjeeling Himalaya at 3,000 to 5,000 feet, also in Assam, Sylhet, the Khasia hills and Burma. In Burma it is known as *nwedo*.

Recently a sample of the milk of this plant was furnished by the Conservator of Forests, Tenasserim, Burma, to the Reporter on Economic Products to the Government of India, with a view to obtain particulars as to the value of the caoutchouc and suggestions for a method of coagulation to be adopted with the milk. It was ultimately examined by Dunstan, who gave the analysis as caoutchouc 84·1 per cent., rosin 11·5 per cent., and insoluble matter 4·4 per cent., with ash 1·3 per cent. The rubber was pronounced of a good quality. Further analysis will be necessary, the report continues, before the above results can be accepted as representative, but if furnished in quality corresponding with the sample analysed, it would be readily saleable.

Ficus elastica, *Roxb.*; *Fl. Br. Ind.*, v., 508–9; King, *Ann. Bot. Gard. Calc.*, 1888, i., pt. i., 45, t. 54; Gamble, *Man. Ind. Timbs.*, 641–3; Brandis, *Ind. Trees*, 603; Manson, *l.c.* (reprinted as *Comm. Circ.*, 1901, No. 4, 6); Hooper, *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1903–4, 26; Reinhorz, *Agri. Ledg.*, 1904, No. 4; Bald, *Cult. of Ficus elastica*, 1906; Coventry in the *Forest Bull. Ind.*, 1906, No. 4; Mann, *Assam Rubber and its Commercial Prospects*, in *Agri. Journ. Ind.*, i., pt. iv., 390–8; *Kew Mus. Guide*, 1907, No. 1, 195; Urticaceæ. The India-rubber Fig, Indian Caoutchouc Tree, the *bor*, *attah bor*, *kagiri ranket*, *lesu*, *yok bawadi*, *nyaung kyet paung*, etc. The Karet rubber of West Java—a name which Manson points out may have been derived from the Burmese *kayet* (*kyet*). **D.E.P., iii., 350; iv., 344–60. India-rubber.** Karet Rubber.

A gigantic tree having its leaves and shoots perfectly glabrous, and which usually sends down from its branches numerous aerial roots. It frequently germinates naturally from droppings of birds, and is consequently often at first epiphytic. When under these circumstances it chances to become attached to another tree it grows slowly for the first six to ten years, and when its roots have reached the ground it usually kills the foster plant. It then grows more rapidly and becomes an immense and very lofty tree (from 100 to 200 feet in height). It is met with on Often Epiphytic.

the outer Himalaya from Nepal eastward to Assam, the Khasia hills and Burma, being especially plentiful in the Hukong valley. It usually occurs in altitudes from 1,000 up to 3,000 or sometimes as much as 5,000 feet. It is now largely cultivated both as a shade or ornamental tree and as a source of rubber. For the latter purpose plantations were established in Java as early as 1872, and in Assam in 1874.

Reports on Plantations.

INDIA-RUBBER PLANTATIONS.—From the Assam Forest Department Reports of 1897–8 it may be learned that 88 acres were planted with this fig in Kulsi during 1873–7, and that in 1898 there were 2,411 trees on that plot having an average height of 87 feet 8 inches and mean girth of central bole of 6½ feet; further that in 1878, 13 acres were planted, and the trees were in 1898, 81 feet in height and 9 feet in girth; that 25½ acres were planted in 1883, and the trees on this extension were, when reported on, 67 feet in height and 5 feet in girth; and lastly that in 1884 there was a still further addition made of 33½ more acres, the trees of which were found in 1898 to be 55 feet high and 4½ feet in girth. In the report for 1904–5 (*Prog. Rept. For. Admin. Assam*, 9) it is stated that "56½ acres were exploited, 4,100 trees tapped and 2,550 lb. of rubber obtained. The yield of rubber varied from 62½ lb. per acre in the plantation of 1878 to 30½ lb. per acre in Block II. of the plantation of 1883." "The cost of tapping was Rs. 672 or annas 4, pies 3 per lb.; and of the rubber obtained, 1,488 lb. were sold for Rs. 4,020–6, or Rs. 2–11–3 per lb.; 3 lb. were kept as a sample and 1,059 lb. sent to London for sale."

Charduar Plantation.

In the Charduar plantation there were in 1898, 1,700 acres under this fig. Experimental tappings were made in 1896–7 and 1897–8. These gave for 21 trees 46 and 48 lb. of rubber respectively, *i.e.* 2·19 and 2·29 lb. per tree. The rubber produced was in England valued at 2*s.* 3*d.* to 2*s.* 9*d.* per lb. In the report for 1904–5 it is said that "in the Charduar and Bamoni Hill plantations, Darrang Division, 367½ acres were worked, 7,103 trees tapped, and 9,817¾ lb. of rubber obtained. The yield of rubber varied from nearly 37 lb. per acre in compartment 3 to 17½ lb. per acre in compartment 11 of Charduar. In Bamoni Hill plantation only 5 lb. per acre were yielded, but this is accounted for by tapping being confined to small suppressed trees." Home (*Ind. For.*, 1899, xxv., 70) estimates the annual yearly outturn from these Government plantations at 8,000 lb. of rubber, which at 2*s.* 8*d.* would give a gross return of Rs. 16,000 or a net return of Rs. 10,400, or say 9 per cent. on the capital cost of the plantations. But does this estimate include the cost of management, rent and interest? Plantations on a much smaller scale have been attempted in Madras and Mysore.

Seed.

Seasons.

PROPAGATION.—According to Claud Bald, "the prime requirements for raising this rubber are two: high, or well-drained land, and a hot steamy climate." Fruit is produced from March to October, but according to Bald, the best seed is obtained in the hottest months, May, June and July. When collected the fruits or figs are dried in the sun and mixed with powdered charcoal to preserve them. They are about the size of peas, and at the time of sowing are broken up, and the seed thus sown mixed with portions of the disintegrated fruit. Light, sandy loam is most suitable for seed-beds and the best time for sowing would appear to be during the rains, viz. from June to September; but in some of the Government experiments the sowings are made in January and others in October. Bald recommends sowing in seed pans or boxes covered with glass. The seed is lightly scattered over the surface of the ground, and germinates about three months later. But the drainage of the beds must be perfect, and the ground allowed to become neither very wet nor very dry, and at the same time the plants

Transplanting.
Cuttings.
Epiphytic Tendency.

must be shaded from the sun for some time. When 2 to 3 inches high, the seedlings should be transplanted to a properly dug nursery-bed, well raised and drained. They should then be planted in lines about one foot apart. When 1 to 2 feet high, they may be put out in their permanent positions, but it is preferable to retain them in the nursery till they are 10 to 12 feet high, so as to prevent them being eaten by animals. In artificial planting it is found that rubber grows best on mounds. In the Kulsi plantation of Assam, lines are cut through the forest 20 feet wide and 50 feet apart from centre to centre. On these lines 15-foot stakes are put up 25 feet apart. Round each stake a mound is thrown up, 4 feet high, on which the rubber seedlings are planted. In the Charduar plantation the lines are 100 feet apart and the trees planted 50 feet apart, but the cleared lines of 20 feet were found insufficient and so were widened to 40 feet, thus effectually checking drip and affording the light necessary for full growth. The trees may also be propagated from cuttings, which must be from young fleshy shoots obtained by pollarding several branches of an old tree and allowing them to send out shoots. The best time to take cuttings is May and June. Both in Sikkim and Assam the epiphytic tendency of the plant has been simulated by tying seedlings or cuttings growing in baskets on to trees and allowing them to become attached to and to kill the trees in the way already mentioned. Gamble gives a full account of the methods of propagation pursued in various plantations which the reader should consult, as also the pamphlets by Bald and Coventry.

Indian Caoutchouc.
Method of Collection.
Alum used in Coagulation.
Yield.

INDIAN CAOUTCHOUC.—Most of the India-rubber procured from India has been collected from wild trees in the natural forests. It is collected by the hill tribes in tracts beyond the British frontier, and sold to the people of the plains in the form of balls that have to be carefully examined for stones or mud placed in the centre. The Government plantations have recently begun, however, to contribute a superior rubber, the proportion of which is likely to be yearly increased. The latex is collected during the dry months. Eight oblique cuts are made on the main stem, sloping downwards and at a little distance from each other. The best tool for making these incisions is said to be a carpenter's gouge worked with a small mallet. These incisions should not be deep, as the milk is secreted just below the outer bark, and the lowest should be about 4 feet from the ground. Below the incisions pots or *kalsies* are tied round the tree one underneath the other, which are left attached for the day. The trees should be tapped only once in three years. If tapped yearly they are liable to die. A few spoonfuls of a watery solution of alum are usually put in each vessel of milk, after it has been purified of extraneous matter. The milk coagulates and the rubber is exposed to air on sticks and allowed to drain for a week. In a month it is ready for the market. The yield from each tree in the Assam plantations at the present day is approximately 8 oz. per annum, and the average age of the trees is about 26 years; but according to some writers, the trees may be tapped at 14 years. E. S. Carr's remarks (*Ind. For.*, June 1905, xxxi., 335–7) regarding method of tapping pursued in Assam and the coagulation of the rubber should prove instructive to those interested in the subject, and an article by Mann (*The Tapping of Assam Rubber*, in *Agri. Journ. Ind.*, 1907, ii., pt. iii., 277–9) should also be consulted.

Governing Factors.

Recent Publications.—Mann (*l.c.* 393) reviews in a forcible manner the opinions and conclusions arrived at by Bald, Coventry and Eardley-Wilmot (in the most recent publications mentioned above on the subject of Indian *Ficus elastica*). He writes, "The factors which will determine the practical success of Assam rubber may perhaps be set out as follows :—

(1) " The initial or capital cost of forming a rubber plantation and bringing it into bearing.

(2) " The age at which the trees will commence to yield.

(3) " The yield which may be expected per tree and per acre.

(4) " The cost of working a bearing plantation, collecting the rubber, and placing it on the market.

(5) " The value per pound of the rubber produced.

(6) " The permanency of the plantation."

Private Enterprise.

Mann endeavours to obtain from the publications in his hands an answer to each and every one of these issues, or to show where and in what way available particulars are wanting. His object is, from first to last, to ascertain if experience and knowledge obtained in North-East India justify extended cultivation by private enterprise, and the form which it should assume. As he confesses, his

Disappointing.

By-product with Tea.

Value
Impr
Meth

conclusions are disappointing. He continues, "The prospects are so doubtful, and even if successful so poor as compared with the culture of Para or Castilloa rubber in Ceylon, the Malay States, or even South India, that one is inclined to consider any large extension of the culture of ***Ficus elastica*** in North-East India as out of the question. And I must say that this impression has been very strongly confirmed by almost all that I have seen in these districts, if the Assam rubber is to be cultivated as a separate industry. On the present evidence the length of time which it is necessary to wait for returns, the smallness of the returns when they are obtained, the doubt as to the market fifteen or twenty years hence, would seem to make investment in Assam rubber culture, as a separate venture, a very doubtful speculation in North-East India at any rate. I do not see how, at the rate of outturn obtained now at Tezpur, more than Rs. 15 to Rs. 18 per acre profit could be obtained per annum; and even if this were multiplied by four it would hardly be attractive enough to induce an investor to wait over twenty years for the result. In fact, the only possibility of ***Ficus elastica*** culture would seem to be as a by-product to tea culture, on land now waste and unsuitable for tea. In this case, the growth of Assam rubber may afford a means of turning land to profitable account which would otherwise only remain useless to its owners. It may be that future discoveries with regard to improved methods of tapping, new methods of growth, means of tapping the plants annually without injury, or of growing a larger number of healthy heavily-yielding plants on the same area, may alter the opinion above expressed. But as it stands, and with the data before us in the two pamphlets under review, I feel that no other conclusion is possible than that Assam rubber culture can only continue as a dependent of another larger and more profitable industry, and then can only occupy the inferior land."

Chemical Analysis.

Chemistry.—A representative sample of 1903–4 rubber from the Charduar rubber plantation was submitted to analysis in the Scientific and Technical Department of the Imperial Institute, and gave the following results:—The rubber was of a reddish-brown colour, but showed here and there small white patches. It was highly elastic and tenacious, dry, clean and free from stickiness. It was completely soluble in chloroform, carbon disulphide and benzene, and partially in ether. The analysis was as follows:—caoutchouc 76·67 per cent., resin 19·2, albuminoid matter 1·5, dirt and insoluble matter 1·7, moisture 0·9, ash in dirt 0·5. A high percentage of resin appears characteristic of rubber from the Charduar plantation. No precise data are available to show how the composition of rubber varies with the age of the tree or locality from which produced. A specimen of Assam rubber examined by Hooper gave the following:—resin 12·65, caoutchouc 85·95, water 1·0 and mineral matter 0·40, while a sample of Andaman rubber (from this tree) gave resin 4·87, caoutchouc 67·06, water 27·57 and mineral matter 0·50 per cent. There is thus a wide diversity in composition which it seems essential should be explained.

Trade.

Exports.

Price Realised.

Trade.—The imports into India across its land frontier, more especially into Assam, are considerable. During the year 1901–2 these came to 1,470 cwt., valued at Rs. 1,55,656; in 1902–3, 733 cwt., valued at Rs. 65,912; in 1903–4, 1,601 cwt., valued at Rs. 1,66,629; in 1904–5, 3,083 cwt., valued at Rs. 3,50,773; in 1905–6, 2,587 cwt., valued at Rs. 3,56,413; and in 1906–7, 2,330 cwt., valued at Rs. 3,03,194. Of these amounts a very large proportion usually comes from the Naga and Mishmi hills. Recently the Government plantations have begun to contribute to the annual supply something like 3,000 lb. The exports from India to foreign countries in caoutchouc (mostly the produce of ***F. elastica***) were in 1903–4, 1,792 cwt., valued at Rs. 3,47,196, and in 1906–7, 4,489 cwt., valued at Rs. 11,18,487; but the traffic fluctuates very greatly, especially the supply drawn from Burma, for in 1899–1900 the foreign exports were returned at 8,169 cwt., valued at Rs. 15,80,729. These foreign exports are usually drawn from Bengal (including Assam) and Burma, and are consigned chiefly to the United Kingdom and the United States. In a report furnished by the Director of the Imperial Institute (Feb. 3, 1905) the value of the Charduar rubber is stated to have been 3*s*. 8*d*. per lb. on the London market. For insulating purposes, however, the value of this rubber is stated to be only 3*s*. 3*d*. per lb., owing to the large quantity of resin which it usually contains.

[*Cf.* Mann, *Rept. on Caoutchouc Tree in Durrung Dist.*, in *Journ. Agri.-Hort. Soc. Ind.* (*Select.*), n.s., 1869, i., 71–81; *For. Admin. Rept. Beng., Assam, Burma* (many passages during past ten to fifteen years); *Ind. For.*, 1890, xvi., 473–4; 1893, xix., 346–52; 1897, xxiii., 240–1, 420–1; 1898, xxiv., 206–9; 1899, xxv., 63–4; 1900, xxvi., 569–85; *Kew Bull.*, 1891, 97–100; 1892, 68, 70; 1896, 171–4; 1898, 177–81, 312; Morris, *Cant. Lect., l.c.* 1898, 785–9; Thomson, *Rept. on Hukong Valley and Upper Mamkong Basin*, 1895, 10–7; R.E.P., *Comm. Circ.*, 1896, Nos. 3, 12; 1897, No. 1; 1898, Nos. 5, 10; 1899, No. 2; 1900, Nos. 8, 11, 12; 1901, Nos. 1, 4; *Gaz. Upper Burma*, 1900, ii., pt. 1, 325–35; Ribbentrop, *For. in Brit. Ind.*, 1900, 198–221; Nisbet, *Burma under Brit. Rule and Before*, 1901, ii., 77; Mukerji, *Handbook Ind. Agri.*, 1901, 488–9; *Imp. Inst. Tech. Repts.*, 1903, 145–57; Jumelle, *Les Pl. à Caout., etc.*, 1903, 11, 13, 17, etc.; *Journ. Soc. Chem. Indust.*, 1904, xxiii., 1154; *Rev. des Cult. Colon.*, 1904, xiv., 246; Tschirch, *Die Harze und die Harzbehälter*, 1906, ii., 1010–2; Wright, *Cocoa*, 1907, 80; Wright, *Rubber Cult. in Brit. Empire*, 1907, 27–8.]

Lagos Rubber.

Funtumia elastica, *Stapf*; APOCYNACEÆ. This is the *ire* or Lagos Rubber plant, which previously was known as *Kickxia elastica*. It is being experimentally grown on the Nilgiri hills, etc. [*Cf.* Morris, *Cant. Lect., l.c.* 776–7; *Kew Bull.*, 1895, 241–7; 1899, 29–35; *Agri. Bull. Straits and Fed. Mal. States*, 1903, ix., 136–8; *Bull. Imp. Inst.*, 1903, 160–3; Johnson and Thiselton-Dyer, *Rubber Repts. of Gold Coast and Sierra Leone Col. Repts. Misc.*, 1904, No. 28; Wright, *Cocoa*, 1907, 79; *Kew Bull.*, 1907, 187.]

D.E.P., iv., 365–72.

Hancornia speciosa, *Gomez*; APOCYNACEÆ. This yields the Mangabeira or Pernambuco Rubber of commerce—exported from Brazil (*Kew Mus. Guide*, 1907, 148).

Para or Hevea Rubber.

Hevea brasiliensis, *Mull. Arg.*; Hemsley, *Kew Bull.*, 1907, 154; EUPHORBIACEÆ. The PARA RUBBER TREE. This and one or two allied species occur in the forests of Central and Northern Brazil, and in the forests of Para from the mouths of the Amazons, south and west. They all yield rubber. The region indicated has a climate remarkable for its uniformity of temperature, 87° F. midday and 74° F. at night, the mean being 81° F. and the highest record 95° F. The rainfall occurs principally in January to June, the maximum being in April, when it reaches 15 inches. It is a very healthy region with a remarkably fertile and continuously moist soil. The trees grow rapidly and attain some 30 feet in three years.

Protection Necessary.

Six-year-old Tappings.

Method of Tapping.

By far the best rubber is obtained from the species of this genus. In fact, where *Hevea* can be profitably grown it will never pay to cultivate any other rubber plant. The rubber afforded is stronger and possesses a much higher breaking strain than that of any other plant, its tenacity being due, so it is thought, to the method of coagulation. Once established, *Hevea* requires but little care, and rough weeding will suffice. It is, however, liable to several pests, more especially canker, and has to be protected from browsing animals (deer, etc.) when in the young plantation stage. The trees may be tapped when about six years old, but they come into full bearing in eight to ten years. Success is closely connected with the methods of tapping and curing pursued; absolute cleanliness is indispensable. The bark of the trees about to be tapped should be first cleaned and the V-shaped cuts on the perpendicular central channel made with decision and thoroughly cleansed before the milk begins to flow. Dust, sand and other impurities greatly lower the value of the rubber, since they can with difficulty be subsequently removed. Deliberate adulteration once proved will permanently ruin a plantation or source of supply.

Indian Production.

INDIAN ACCLIMATISATION.—This rubber tree has been successfully cultivated in Mergui and Tavoy. It has also been fully acclimatised in the south-west districts of Ceylon, where so much attention has been paid to the preparation of the rubber that it has actually fetched a higher price than that from the indigenous home of the plant; but while, owing to its purity, it is valuable for waterproofing, it seems to lack the tensile strength of the rubber of Para.

History.

Burma.—In the *Dictionary* will be found a brief review (an abstract from Thiselton-Dyer's report) of the historic facts regarding the introduction of this plant into Asia from seed germinated at Kew. The first endeavours in Burma date from a small consignment of plants sent to Mergui by Sir

Mergui Plantations.

Yield.

George King in 1877. A second consignment was obtained in 1879 from Ceylon. In 1884 some of the better established plants began to seed, and an acclimatised stock of seedlings was thereby obtained. Manson, in his *Short History of the Mergui Rubber Plantations of that Province*, has carried the record to the present date. In May 1900 sanction was accorded for the gradual formation of a plantation of 10,000 acres of ***Hevea*** trees. This was to be located, 5,000 acres in the Sandawut reserve and a similar area on King Island. The work was started in 1901 by 46 acres being planted out, 12 by 12 feet. By 1904, 1,518 acres had been planted, and the operations have since been vigorously prosecuted, annual extensions taking place according to the scheme sanctioned. The purpose in view has been to demonstrate the commercial possibilities of this rubber cultivation in Mergui. Already 929 lb. of rubber have been produced, and the nurseries, according to the last report, contained 600,000 plants, with an addition of 100,000 self-sown seedlings in the original experimental garden. In the *Annual Report Forest Administration of the Tenasserim Circle* (1904–5, 31–3), W. F. L. Tottenham, Conservator of Forests, gives the results of a further year's efforts. The total amount of dry rubber collected during 1904–5 was 1,450 lb., of which 54 lb. 6 oz. were collected during the rains. The cost of collection came to about 11 annas per lb. The area was intended to have been extended by 1,250 acres, but owing to an outbreak of cholera only 818·65 acres were added to the plantation. Of that expansion 736·87 acres were in Mergui, and 81·78 acres on King Island. The conservator of the Northern Circle (*l.c.* 52) says that ***Hevea*** has not proved a success in the Katha Division. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1906–7, 6) mentions the result of examination of a sample taken from a white-ant's nest (***Termes gestroi***). The rubber was of great excellence, the resin having apparently been extracted by the ants.

Private Enterprise.

Thus, then, it may fairly be said that Brandis, who early foretold success for Tenasserim Para-rubber cultivation, has been abundantly confirmed, and the future seems destined to see large developments. Already private enterprise is engaged in the business, and doubtless when the possibilities in this direction of its forest property have been fully established, Government may withdraw. (*Ind. For.*, Sept. 1905, xxxi., 330–4). For methods of propagation and systems of tapping the trees, consult the technical publications, more especially the circulars issued by the Director of the Royal Botanic Gardens, Ceylon.

South India.

South India.—A good deal of interest has recently been taken in the possibility of Travancore and even of Mysore becoming hopeful localities for Para-rubber cultivation. It is said by planters and others that thousands of acres of heavy forest-land, below 1,000 feet in altitude, exist that possess rich soils and a liberal rainfall, eminently suited for rubber, but which at present are valueless because not put to any purpose. Some progress has, however, been made, but taking South India as a whole, Para rubber has not so far been the unqualified success anticipated. A writer in the *Madras Mail* (March and April, 1905) seems to take a hopeful view, however, and the subject has by no means been abandoned.

Bengal.

Bengal and Assam.—Considerable efforts have been made to organise Para-rubber plantations in Northern and Eastern India, but with little encouragement so far. The trees have been planted out in Kurseong, Jalpaiguri and Buxa, but the reports of the Forest Department cannot be said to be favourable. [*Cf.* Mann, *Cult. of Para Rubber in North-East Ind.*, in *Agri. Journ. Ind.*, 1907, ii., pt. iii., 273–6.]

[*Cf.* Robert Cross, *Rept. Investig.*, 1877, reprinted in *Ind. For.*, 1879, iv., 5–26; *Notes* on same, *l.c.* 1882, viii., 62–5; Temple, *The Rubber Industry in Amazonas State, Dipl. and Cons. Repts. Brazil, Misc.*, 1900, 530; *Agri. Bull. Straits and Fed. Malay States*, 1903, ii., 99–105; Willis, *Circ. Roy. Bot. Gard. Ceylon*, 1898, No. 4, 23–36; 1899, 105–68; *Kew Bull.*, 1898, 241–77; Morris, *Cant. Lect.*, *l.c.* 750–60; Mukerji, *Handbook Ind. Agri.*, 1901, 485–9; Stanley Arden, *Rept. Fed. Malay States*, 1903; *Agri. Bull. Straits and Fed. Malay States*, 1903, ii., 1–4, 44–8; Thiselton-Dyer, *Ten-year-old Trees*, 70–1; Rodrigues, *The Heveas or Seringueiras*, 12–6, 57–61; Pears, *On Preparation of Crude Rubber*, 1904, iii., 119–20, 159; *De Indische Mercuur*, 1904, 309–10, 327–9, 330, 439–40; *Agri. Bull. Straits and Fed. Mal. States*, 1904, iii., 311–9, 339–88, 405, 412–8, 441–2; *Hawaiian For. and Agri.*, 1904, 290–1; *Trop. Agrist.*, 1905, 446–8; Johnson, *Cult. and Preparation of Para Rubber*; Tromp de Haas, *Results of Exper. Tappings of Hevea Brasiliensis*, in *Cult. Econ. Gard. Tjikeumenh*, 1900–4, transl. in *Agri. Bull. Straits and Fed. Mal. States*, Aug. 1905, iv.; *Bull. Imp. Inst.*, 1904, ii., No. 3, 187–91; *Agri. Bull. Straits and Fed. Mal. States*, 1905, 1–3, 71–7, 226–30; Cook, *Cult. Cent. Am. Rubber Tree, U.S. Dept. Agri. Bull.*, No. 49; *West Ind. Bull.*, 1905, v., No. 3, 210–5; *Trop. Agrist.*, 1905, xxv., 216–21, 305–35; Wright and Bruce, *Para Rubber in Ceylon, Agri. Journ. Roy. Bot. Gard. Ceylon*, 1905, iii., 55–86; *Utilisation of Para Rubber Seed-oil and Cake*, in *Bull. Imp. Inst.*, 1903, 156–9; 1904, 22–3; Tschirch, *Die Harze und die Harzbehälter*, 1906, 993–1005; Butler, *Disease of Rubber Trees*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 260–1; Sly, *Rubber Exper. in Bomb.*, 1906, i., pt. iv., 415–6; *Rubber Exper. in Bomb.*, 1907, ii., pt. i., 80, 85–92; Wright, *Cocoa*, 1907, 77–8; Wright, *Rubber Cult. in Brit. Empire*, 1907, 18–9.

D.E.P., iv., 372–4. African Rubber.

Landolphia Kirkii, *Dyer*, and **L. owariensis**—East and West African Rubbers; APOCYNACEÆ. A genus of climbing plants, met with in Africa, of which several species afford rubber. To Sir John Kirk is due the honour of having first directed attention to these plants. Sir George King, in the Annual Report of the Royal Botanic Gardens of Calcutta for 1880–1, reported the germination of seeds obtained through Kirk. The plants unfortunately, however, subsequently died. At the Nilambur plantation of the Nilgiri hills, further efforts were made to acclimatise this plant. About the same time thirty-four plants were reported as doing well in South Malabar. In the report of the Government Botanic Gardens, Bangalore (1897–8), it is spoken of as growing like a weed. In the Report for 1902–3, Cameron wrote: "Much nonsense has been written lately concerning a new rubber plant *Landolphia Thollonii* found on the French Congo." . . . "The latex of this little shrub, which is only half a foot high, is chiefly stored in the root." "The African genus *Landolphia* promises to be a large one, and doubtless all the species may be found to contain latex. We have one or two species on trial which grow well. But as climbing plants they are not, in my opinion, very suitable for rubber-farming in this country." Manson (*l.c.* 8) observes that the Landolphias have recently been tried in Mergui and in the Rangoon Division of Pegu Circle. [*Cf. Ind. For.*, 1882, vii., 233–7; 1897, xxiii., 61–3; 1900, xxvi., 129–34, 313–30; *Annals* of *Botany*, 1900, xiv., 203; Christy, *New Comm. Pl.*, No. 1, 8–10, and plate; No. 6, 54–6; *Kew. Bull.*, 1899, 35–9; Morris, *Cant. Lect.*, *l.c.* 1898, 773–6, 779–82; Sadebeck, *Die Kultergew. der Deut. Kolon.*, etc., 1899, 270–7 and plates; *Rev. des Cult. Colon.*, Feb., 1900 121; 1901, 218; 1902, 75; *Bull. Econ. Madag.*, 1902, 143, 145–6, 251; *Imp. Inst. Tech. Repts.*, 1903, 152–4; Jumelle, *Les Pl. à Caout. et à Gutta*, 1903, 284–352; *Agri. Journ. Natal*, 1903, 25; *Bull. Imp. Inst.*, 1903, 68–71, 168–9; 1904, 94–5; suppl., 95–6, 105–6, 153–6; 1905, 221–2; *Bull. Imp. Inst.*, 1905, iii, 14–8; *De Indische Mercuur*, June 1904; Tschirch, *l.c.* ii., 1013–4.]

Introduction into India.

D.E.P., iv., 374–8. Ceara Rubber.

Manihot Glaziovii, *Müll. Arg.*; EUPHORBIACEÆ. Ceara Rubber, Scrap Rubber, Manicoba Rubber. Cross described the tracts in Brazil where he found this plant as possessing a dry arid climate for a considerable part of the year. The rainy season, he says, begins in November and continues till May or June, though there are occasionally almost rainless years; the temperature ranges from 82° to 90° F., and the altitude is about 200 feet above the level of the sea. Ceara is a coast town in lat. 4° S.

In the early experiments at acclimatisation of rubber trees in India (1876 and subsequently) it was ascertained that while Ceylon had better be treated as the centre of the experiments with *Hevea* and *Castilloa* rubbers, Calcutta might with advantage be made the depôt for Ceara. Sir George King accordingly wrote, in the *Annual Report of the Royal Botanic Gardens of Calcutta* for 1880–1, that the Ceara rubber trees continue to grow vigorously, and a few are now beginning to yield seed. In the same year, in the *Annual Report of the Botanic Gardens, Nilgiri Hills* (Barliar), it is said that the Ceara trees are now completely established. Lawson, for example, wrote that Ceara trees "grow very rapidly, and to all appearance thrive well; but I have been wholly unable to extract rubber from them in anything like a paying quantity, and every one else hitherto has also failed." In the report for 1890–1 the record is made of eight trees having been tapped for rubber. In the *Report of the Conservator of Forests, Madras* (1891–2) it is stated that in North Malabar this rubber tree grows like a weed and some of the trees are 46 feet high. In 1895–6, 309 trees were tapped in South Malabar and gave an average of 1 oz. per tree of dry rubber, valued in England at 1*s.* 6*d.* to 1*s.* 9*d.* per pound. Mr. R. L. Proudlock, in 1898, tapped a tree eighteen years old in the Barliar garden, and by a single tapping obtained 2¾ oz. of dry rubber. Ceara, he adds, is quite at home and will grow almost anywhere on the Nilgiris up to 4,000 feet in al-

South India.

titude. Mention is often made of a fairly extensive cultivation in South Coimbatore. Cameron (Superintendent of the Botanic Gardens, Bangalore) has repeatedly reported on this rubber. Experiments were commenced with it as early as 1879. After enumerating the production and distribution of seed from the gardens during the past twenty-five years, he adds that Ceara rubber is now tolerably common in many parts of the Province. In a report published in the *Mysore Gazette*, April 1904, he further gives useful particulars of planting, propagation and tapping of the trees. In the ***Forest Dept. Reports of Burma*** mention is made of successful acclimatisation in Mergui. In 1896 a valuation of 2*s.* a pound for the rubber was obtained.

Experience Attained.

It is hardly necessary to deal with other reports since enough has already been furnished to give a fairly satisfactory conception of the efforts made and results attained in India. But it may be useful to conclude with the following as indicating the opinions held by experienced scientific authorities in Europe:—The *Kew Bulletin* summarises the results obtained somewhat as follows:—1. The plant is readily propagated by seed or cuttings. Seeds are abundantly produced in almost every part of the world where the plant has been introduced. Sowing in the permanent position is universally adopted in Brazil. 2. The Ceara rubber plant is very hardy, a fast grower, free from insect and fungoid attacks, requires little or no attention when once established, and thrives in poor, dry, rocky soils unsuited to almost any other crop. Large plantations only are likely to prove remunerative. 3. It produces a good class of rubber, second only to the best Para. The yield is small per tree, but a return is obtained earlier than from any other species. Under skilful treatment the trees may be tapped twice yearly, and last in a productive state for fifteen to twenty years. 4. In spite, therefore, of the apparent want of success in Ceylon and other countries, the increasing importance of rubber suggests a reconsideration of the merits of this interesting plant.

Starch yielding Tubers.

Both in India and Burma mention is made of the fact that the large starch-yielding tuberous roots of this tree have been discovered by the wild pigs, and considerable damage done by them in seeking out and devouring the tubers. This fact suggests the possibility of these starch-yielding tubers becoming an additional source of revenue, should an extended cultivation take place. [*Cf.* Cross, *Ind. For.*, 1879, iv., 27–45; ***Notes Ceara Rubber*** in ***Ind. For.***, 1882, viii., 58–61; 1897, xxiii., 456–8; 1898, xxiv., 460–1; ***Proc. Madras Board Rev.***, Oct. 1894, No. 712; Nov. 1897, No. 914; 1899, No. 518; Aug. 1904, No. 906; Morris, *Cant. Lect.*, *l.c.* 1898, 765–70; ***Kew Bull.***, 1898, 1–15; R.E.P., *Comm. Circ.*, 1897, No. 8; 1901, No. 4; ***Rept. Bot. Gard. Nilgiri Hills***, 1902, 8; 1902–3, 9–12; 1903–4, 5–8; ***Imp. Inst. Tech. Repts.***, 1903, 147–8; Tschirch, *l.c.* 1906, ii., 1006–7; ***Rubber Exper. in Bombay***, in ***Agri. Journ. Ind.***, 1907, ii., pt. i., 80–1; Wright, ***Rubber Cult. in Brit. Empire***, 1907, 21–2; Wright, *Cocoa*, 1907, 79.]

D.E.P., iv., 361.

Parameria glandulifera, *Benth.*; APOCYNACEÆ. The Talaing Milk Creeper. A large climbing evergreen shrub of the borders of tidal forests on the sea coasts of Tenasserim and the Andaman Islands. It is known as *talaingzok* in Burma. It would appear to have sometimes been confused with ***Willoughbeia edulis***. The milk is obtained by a somewhat destructive method of cutting the stem into short lengths, and allowing the milk to drain into vessels containing water at a temperature of 104° to 122° F. On agitation the milk coagulates. The

Propagation. Yield.

plant may be propagated by cuttings with great facility. The yield seems to be remarkably high and the rubber of fair quality, perhaps equal to that of ***Ficus elastica***. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1906–7, 6) gives the analyses of three samples examined. They contained 92·39, 95·1 and 96·7 per cent. of caoutchouc. A sample from the Andaman Islands he found (*l.c.* 1905-6, 25) contained 92·5 per cent. of caoutchouc, 6·4 per cent. resin and 1·0 per cent. ash. In spite, therefore, of all that has been said to the contrary, this source of rubber seems worthy of more careful consideration than has as yet been meted out to it, and it seems probable that some cheaper

Method of Collection.

and more economical process of collection might be devised than that practised at present, while the cost may be brought within permissible commercial limits.

In this connection it may be added that the percentage of ash is an important factor in determining the values of rubbers. The following average returns may, therefore, be of interest:—Para rubber, 1 to 2·5 per cent. ash; Ceara rubber, 2 to 3 per cent. ash; Assam rubber, 4 to 6 per cent. ash; Parameria rubber, 6·4 per cent. ash in dry rubbers. [*Cf.* Wright, *Rubber Cult. in Brit. Empire*, 1907, 28.]

Valuation.

Rhynchodia Wallichii, *Benth.*; APOCYNACEÆ. A lofty evergreen climber of the Sikkim Himalaya at altitudes of 2,500 feet, also met with in Assam, Sylhet and Burma. Attention has recently been directed to this plant as a new source of rubber by Mr. Hearsey of the Forest Service, Burma. A sample of the rubber was furnished in August 1903 by the Reporter on Economic Products to Prof. W. R. Dunstan for examination. The report, dated May 1904, shows the rubber to contain 89·0 per cent. caoutchouc, 6·7 per cent. resin, 4·3 per cent. dirt, and 0·51 per cent. ash (included in the dirt). It is thus of good quality, but about 1·5 per cent. of the caoutchouc was insoluble in the usual solvents. The brokers' report on the sample was to the effect that, at present prices, it would realise 3*s.* 6*d.* per lb. Dunstan then adds that if supplied of similar quality to the sample examined, it would always sell readily.

Sapium biglandulosum, *Muell.*; EUPHORBIACEÆ. Yields Colombian Scrap or Virgen Rubber from British Guiana and also Bolivian Rubber. [*Cf.* *Kew Mus. Guide*, 1907, 189.]

D.E.P., iv., 361-3.

Urceola elastica, *Roxb.*, and **U. esculenta,** *Benth.* (*Chavannesia esculenta*, *A. DC.*); APOCYNACEÆ. These climbing shrubs yield caoutchouc of good quality. The former occurs in Malacca and Penang and the latter in Burma; common all over Pegu and met with in Martaban and Tavoy. It is known as *kyetpaung* (Burma) and *tophet* (Karen).

Burma Supply.

This rubber appears to have been first described by Dr. Thomson in 1858, subsequently by Mason (1860), and in 1874 Strettell wrote a special illustrated pamphlet on the subject (*The Caoutchouc obtained from Chavannesia esculenta*). Sir W. T. Thiselton-Dyer, as in the case of all the other rubber-yielding plants, contributed largely towards the development of our knowledge of the present species. The *Forest Administration Reports of Burma* contain, almost yearly, numerous brief references to it and its rubber. In 1897-8, for example, mention is made of 2,342 plants being in the Palon and Kimpadi Plantations of Rangoon, which were started in 1874. Perkin (*Circ. R.B.G. Ceylon*, 1899, 162) observes that "the latex from the thin stems, such as bear the leaves or have recently shed them, forms a sticky substance when moulded between the finger and thumb. The plant resembles *Castilloa* in this respect. The latex both from the pith and the cortex of the young stem is sticky, hence it looks as if the true caoutchouc is only formed in the secondary bast." Manson (*l.c.*, reprinted as *Comm. Circ.*, 1901, No. 4, 12) gives many useful particulars.

Results.

Indigenous Production.

In the *Proceedings of the Government of India* (*Forests*, June 1904, No. 5, 18-9) a collection of official communications has been brought together, extending from May 1903 to January 1904, that gives the most recent experience and results in tapping the *Urceola* plants in the special plantations of this species. They can hardly be regarded as conclusive, though highly instructive. On March 21-5, 1900, 469 creepers were tapped, each with thirteen cuts, and the yield came to 11·454 lb., which was not weighed till April 20, 1903. This cost Rs. 29, or Rs. 2·53 per pound. The second tapping took place on December 14-24, 1900, of 508 creepers, each receiving 30 cuts and yielding 9·853 lb. of rubber, which was weighed on January 25, 1901, and estimated to have cost Rs. 51·4 or Rs. 5·20 per lb. The writer of the report accordingly comes to the "conclusion that the cost of collection of the rubber of Chavannesia is prohibitive, and that no profitable industry can ever be developed in connection with it." But as if to show that the experiments conducted and the conclusions drawn from these cannot be regarded as final, he adds that in the Mon Valley in Minbu district the monopoly of collecting rubber from Chavannesia is sold annually by auction for Rs. 250. It is thus clear that better results can be and are obtained than in the special plantation of this plant near Rangoon. Subsequent experiments seem to show that the tappings mentioned are not necessarily conclusive of what can be done at the plantation.

Valuation.

Dunstan, reporting in May 1903 on samples of this rubber, furnished to him for that purpose, observes that this plant yields "a rubber which promises to be of some commercial importance, especially if it can be forwarded in large consignments of the quality represented by the sample now reported on." The analysis showed caoutchouc 81·8 per cent., resin 7·5 per cent., dirt 10·7 per cent., and ash (included in dirt) 1·8 per cent., calculated on dry rubber. The commercial experts consulted compared the rubber with

Tonquin, and gave its valuation at 2*s.* to 2*s.* 1*d.* per lb. Dunstan then adds, "This material is evidently deserving of further attention." *The Agricultural Ledger* (1903, No. 10) gives the results of additional chemical investigations conducted by Leather, as also a note by Mr. S. Carr, Deputy Conservator of Forests, in which the methods of collection of the latex are described.

Valuations. Subsequent samples were forwarded to the Imperial Institute for examination. It was reported that three contained so high a percentage of resin as to throw doubts on their being correctly determined botanically. The others showed a high percentage of good caoutchouc, and were valued in 1904 at from 3*s.* to 4*s.* a lb. [*Cf.* Morris, *Cant. Lect.*, *l.c.*, 1898, 792; *Bull. Imp. Inst.*, Sept. 29, 1904, 156–9; Wright, *Rubber Cult. in Brit. Empire*, 1907, 28–9.]

D.E.P., iv., 363–4. **Willoughbeia edulis,** *Roxb.*; APOCYNACEÆ. The *thitchanknwe*, possibly also *tulaingno* of Burma, and the *lati-am* of Bengal, is an immense climber met with in the forests of Assam, Sylhet, Cachar, Chittagong, Pegu, and Martaban. It yields a large edible fruit, which from a general resemblance to the mango has suggested the name "climbing mango." At one time high expectations were entertained regarding ***Willoughbeia*** rubber. It has since transpired that much of the rubber in question will have to be transferred to other genera, and that so far as the Indian species is concerned (***W. edulis***), it must be no longer considered as a caoutchouc-yielding plant. Low Yield of Caoutchouc. Recent investigations conducted by Dunstan have shown, for example, that the very high percentage of resin (in some samples 84·6 per cent. with only 10·8 per cent. caoutchouc) necessarily exclude it from consideration as a rubber. [*Cf.* Wright, *l.c.* 29.]

Trade. ***Trade in India-rubber and Caoutchouc Manufactures.***—Such particulars (p. 654) as can be procured regarding the production of caoutchouc in India have been given. It remains to exhibit very briefly the traffic in rubber manufactures. There are no local (Indian) manufactures, so that the supplies of goods are drawn exclusively from foreign countries. In 1876–7 the imports of raw caoutchouc and of india-rubber manufactures collectively were valued at Rs. 1,27,759; twenty-five years later (1900–1) they came to Rs. 6,05,594; in 1903–4 to Rs. 7,03,003; in 1905–6 to Rs. 7,78,905; and in 1906–7, Rs. 10,04,782.

It may be here added that the imports into Great Britain during 1902 came to 419,375 cwt., valued at £5,180,262, and in 1906, 607,077 cwt., valued at £9,966,620. Of the last-mentioned amount Brazil alone contributed 253,918 cwt., and the total from British Possessions was 90,453 cwt. The exports equal about one-half the supply (330,252 cwt. in 1906)—the country which takes the largest amount being the United States (126,969 cwt. in 1906).

D.E.P., iv., 383–469. Indigo.

INDIGOFERA (INDIGO), the Dye-yielding Species.

—A genus of LEGUMINOSÆ which comprises some 300 species, distributed throughout the tropical and warm temperate regions of the globe—India having about 40. Western India may be described as the headquarters of the species, so far as India is concerned, 25 (thus fully half) being peculiar to that Presidency. On the other hand, on the eastern side of India (the provinces of Bengal, Assam and Burma) there is a marked decrease in the number of species but a visible increase in the prevalence of those that are met with. It is possible, moreover, that many more species afford indigo than those specially cultivated for the dye. Improvement by Selection of Stock. Accordingly, cultivation of richer dye-yielding stocks has been urged as one of the most rational methods of improvement. [*Cf.* Watt, *Anal. Trade and Comm. of Ind., Madras*, 1899, 4.] This is of supreme moment in the crisis that has overtaken the industry. Prain and Baker (*Notes on Indigofera, Journ. Bot.*, 1902, xl., 60–7, 136–44) have furnished a very instructive paper, which has already proved of the greatest practical value. So also

Leake (*The Localization of the Indigo-producing Substance in Indigo-yielding Plants, Journ. Roy. Hort. Soc.*, 1905, xxix., pts. 1–3; *Annals of Botany*, 1905, xix., 297–310) has devoted much attention to the selection of stock, and the practical results to be attained thereby. Space cannot be afforded here to do more than review very briefly the salient features of these and other special studies. This will be attempted while following the usual rule of treatment in alphabetical sequence of scientific names :—

Indigofera Anil, *Linn.; Mant. Pl.*, 1771, 272; Prain and Baker, *l.c.* 137–40. This South American species is grown in Burma, Eastern Indo-China and Southern China, but never, so far as we now understand, in India proper. Moreover, there would appear to be three very distinct varieties (or perhaps more correctly distinct species, closely allied to ***I. Anil***) that have to be dealt with in this position. These are :—

(*a*) **I. truxillensis,** *H.B.K.; I. tinctoria, var. oligophylla, DC* An American species and very common plant. It apparently was the form chiefly cultivated in the West Indies during Sloane's time, and is the wild indigo of West Indian writers. (*β*) **I. Anil,** *Linn., var.* **polyphylla,** *DC.; I. suffruticosa, Miller, Gard. Dict.*, 1768 (ed. viii.), No. 2. This is the cultivated plant—*Xivhqvilitl pitzahac* of Hernandez (*Nova. Pl. Hist.*, 1651, 108), the wild form of which is the ***I. guatimala***, *Lunan* (*non Linn.*). (*γ*) **I. Anil,** *Linn., var.* **orthocarpa,** *DC.*

I. argentea, *Burm.* (*non Linn.*), *Fl. Ind.*, 1768, 171, an Indian plant that is quite distinct from ***I. articulata***. though often confused with it.

I. arrecta, *Hochst.* (*Schimp., Herb. Abyss. Pl.*, n. 1923, *non Benth*), in Richard, *Fl. Abyss.*, i., 184. The Natal-Java Indigo. This is the well-known *degendeg* (*dek indig*) of Abyssinia and the chief indigo-producing species of Africa outside the area occupied by ***I. articulata***. It is now largely cultivated in Java under the name of Natal Indigo. Of Java, Prain (in a letter to Barber) says, "In the beginning only ***I. tinctoria***, probably introduced from India or Ceylon, was grown. This, however, towards the end of the seventeenth century, was replaced by ***I. sumatrana***, which held its ground for a considerable time. In the West Indies and Brazil the cultivation began with ***I. sumatrana***, which was imported as 'Brazil Indigo.' Later on, however, this plant was displaced by a native species ***I. truxillensis***, which soon was supplanted by another and better native species, ***I. Anil***. This species, ***I. Anil***, has spread all over the world and is even now the most widely grown of the dye-yielding indigoes; when it reached Java it displaced ***I. sumatrana***. In the West Indies ***I. Anil*** finally met with a formidable rival in ***I. guatimalensis*** and in course of time the latter, being recognised as a superior kind, was adopted in Java to the exclusion of ***I. Anil***. More recently in Java ***I. guatimalensis*** has been found to be less valuable than ***I. arrecta***, and the latter has practically taken its place. The historical aspect of the subject therefore indicates the advisability of at least giving a trial to ***I. arrecta*** in Madras. It does not, of course, follow that the plant will thrive, but if it does, it seems clear that it is the best species to grow. In Bihar, where it has been carefully tried, there are objections to the plant which it is hoped may be overcome; but in Lower Bengal it thrives much better than ***I. sumatrana***. The advantages of the plant are twofold. It gives much more leaf, being a much larger plant, and it is stated by those interested in the preparation of indigo to give a higher percentage of dye from the same weight of leaf."

Natal-Java.

History.
Discovery.
Superior Stock.

The objections to which Prain refers have been ably dealt with by Leake. The plant was found to germinate so imperfectly as to render its cultivation unprofitable. It has the same defect as clover, namely, the seed-coat is very hard (Bloxam and Leake, *Acc. Research Work in Indigo*, 1905, 33). What is, therefore, required is a machine that will scratch the seed-coat and thus facilitate germination. Recently in the public press of India it has become customary to read of "Natal-Java seed scarified and ready for sowing" (see p. 671). Bergtheil (*Ann. Rept. Imp. Dept. Agri.*, app., 1904–5) observes that the Java plant contains more potential colouring matter than do any of the plants ordinarily cultivated in Bihar. Mr. H. A. Bailey, who visited Java in 1899 on behalf of the Indigo Improvements Syndicate, was apparently the first person who pointedly directed the attention of Indian planters to this stock. F. M. Coventry furnishes returns which would seem to justify the opinion that the Java plant shows an increase of 35 per cent. in the amount of green plant cut per acre and of 45 per cent. increase in vat produce, over the ordinary plant of the United Provinces.

Scarified Seed.

Percentages.
Improvement.

Egyptian. **I. articulata,** *Gouan, Illust.*, 1773, 49. This is *I. argentea, Linn., Mant. Pl.*, ii., 273, *non Burm.*; *I. spicata, Forsk.*; *I. cærulea, Roxb.* Is the plant which yields much of the indigo of Arabia and Egypt, still sometimes met with in Western India and as far to the east as Bandelkhand and the Kistna highlands. Was formerly the species most largely grown in the Bombay Presidency, but nowadays is only occasionally seen under cultivation in Rajputana and Sind. Prain says that in the time of Roxburgh and Hamilton (1803–14) the Egyptian indigo still survived as an Indian species (probably escaped from cultivation) in Bihar, but now it seems to have quite disappeared from that region.

I. longeracemosa, *Boivin, Herb.*; *Baillon*, in *Bull. Soc. Linn. Paris*, 1883, pt. i., 399; Prain and Baker, *l.c.* 144. In the letter by Prain, to which reference has already been made, there occurs the following passage:—"In Madagascar and Zanzibar there is a species—***I. longeracemosa***, very distinct both from ***I. tinctoria*** and from ***I. sumatrana***—that is valued by the people of these islands beyond all the other species they grow, and they grow the following:—(*a*) and *chiefly* ***I. anil***, (*b*) less often ***I. tinctoria***, (*c*) occasionally ***I. sumatrana***, and (*d*), in the highlands of Madagascar, ***I. arrecta***." Prain then adds that as long ago as 1875–6, Col. Beddome found this very species both in Travancore and Tinnevelly, and subsequently it was found by Lawson in Travancore.

Forms of Tinctoria. **I. tinctoria,** *Linn., Sp. Pl.*, 1753, 751. Prain and Baker establish two chief varieties of this species with several very distinct cultivated states under these, some of which may have to be viewed as worthy of distinct specific positions. The following abstract may be regarded as setting forth the salient points:—

(*a*) *var* **macrocarpa,** *DC.* The special forms of this are:—

THE WILD PLANT, apparently unknown to Linnæus or De Candolle. It was found in Nubia by Kotschy in 1841, and specimens which agree with it in every essential have also been found in Central India. Regarded as a distinct species its name would be ***I. Bergii***, *Vatke.* [*Cf.* Duthie, *Fl. Upper Gang. Plain*, i., 255.]

Madras Stock. THE SOUTHERN OR MADRAS AND CEYLON cultivated stock. This is the plant dealt with by Linnæus in his *Flora Zeylanica*, and by Burmann in his *Flora Indica.* This particular form would thus appear to have been early cultivated in Southern India, though recently it has very possibly been completely displaced by ***I. sumatrana***. "It was and still is the ***I. tinctoria*** of the cultivators in the Dutch Indies, where, however, the species is not now much in favour. Specimens of this form, evidently feral after escape, have been communicated from many places both within and beyond the limits of the area where it now is, or formerly has been in cultivation." Prain and Baker, from whom the above has been derived, add that they have seen specimens of this particular plant from the Philippine Islands; from North Queensland; from the Laccadives, where it is described as forming thickets that cover a great portion of Kadamum Island; finally from Merwara in Rajputana, where it is not, and probably never has been cultivated. It is a wild plant in Merwara, growing by the sides of ravines, and bears the vernacular name of *jinjini*.

Northern Stock. THE NORTHERN CULTIVATED FORM.—This is largely in use in Northern India from Bihar and Tirhut westward by north to the Panjáb, where its area meets that in which some form of ***I. argentea*** is grown, and southward to the Circars, where ***I. tinctoria*** occurs. This, throughout the area specified, is the plant known as *nil*, and is the form to which the name ***I. tinctoria*** is applied. "It is not exactly what Linnæus meant by ***I. tinctoria***: it is, however, precisely what Gaertner intended by ***I. sumatrana***, and what Lamarck has figured as ***I. indica***, but not the same thing as the old ***I. indica*** of Miller, which is ***I. hirsuta***, *L.*" (Prain and Baker, *l.c.* 65). In the Annual Report of the Royal Botanic Gardens, Calcutta, for 1901–2, it is observed that while the Dutch held possession of Malabar this indigo plant, "apparently derived from the Eastern Malaya, came into use there." Prain (in the letter above mentioned) observes: "About that time, 1686, there was cultivated in Malabar a different plant, ***I. sumatrana***, which seems to have been introduced a little later (whether from Malabar or directly from the Malaya cannot be traced) into Bengal, where prior to its introduction, indigo was not grown at all. This plant, which generally passes under the name of ***I. tinctoria***, although it is not precisely the same as the true plant of that name, has now spread gradually westward and has driven out almost completely the cultivation of the Egyptian indigo." "But what has happened in Northern India has also happened more recently in Madras." "This is all the more remarkable, because in all the older collections, such as those of

Tropical Africa.

Wight, Stocks, Law and G. Thomson, ***I. sumatrana*** was reported only from Malabar and the Konkan, the Coromandel plant being always ***I. tinctoria*** proper." It is also the form of ***I. tinctoria*** that was introduced from the East into the West Indies, and is the ***I. tinctoria*** of Lunan. If, therefore, it be deemed necessary to give this plant a separate name and to remove it from being one of the cultivated states of ***I. tinctoria***, *Linn.*, then it will have to be called ***I. sumatrana***, *Gaertn.* In addition to India it also occurs in tropical Africa and Formosa. It may be distinguished from the southern form by its leaflets, which are larger and ovate-oblong or oblong, instead of obovate or suborbicular. The pods are also (in ***I. sumatrana***) shorter, thicker, and blunter at the apex, and are usually more numerous and straighter than in the Madras form (Duthie, *l.c.* 255). Leake has devoted much careful study to the cultivated races of this plant in relation to temperature and rainfall. His conclusions regarding the seed supply will richly repay careful perusal.

America.

(β) *var.* **brachycarpa**, *DC.* This form has been sent from Guatemala, Central America, Peru, etc. It is apparently not met with in India.

History.

Nílá.

Anil.

Other Indigo-yielding Plants.—The Indigo of modern commerce is thus obtained from one or other of the species of ***Indigofera*** discussed above. But species of *Indigofera* are distributed throughout the tropical regions of the globe (both in the Old and New Worlds) with Africa as their headquarters. And in addition to the Indigoferas several widely different plants yield the self-same substance chemically. Hence, for many ages, the dye prepared from these has borne a synonymous name in most tongues, and to such an extent has this been the case that it is impossible to say for certain whether the *nílá* of the classic authors of India denoted the self-same plant which yields the dye of that name in modern commerce. The word *nílá* simply means dark-blue colour, and is practically synonymous with *kála* (black). It is often used adjectivally, such as in *nílgao* (the blue bull), *nílopala* (the blue stone or lapis-lazuli), *nílamani* (the sapphire) and *nílufar* (the blue water-lily). *Níla* carries, too, the abstract "darkness," and only becomes a substantive to denote the dye-yielding species of *Indigofera* at a comparatively recent date. *Anil* comes from the Arabic *al-níl* through the Portuguese, and should have been written *anníl.*

Woad.

Various Indigoes.

The woad of the early European authors (***Isatis tinctoria***) is grown to-day in Centra Asia and has been so for ages past—a region where no species of *Indigofera* has been known to be grown (or possibly could be grown) as a source of indigo. The Sanskrit people may accordingly have first made acquaintance with the indigo of *Indigofera* in India itself, and it is just possible that their *nílá* may have originally been the woad, which with the ancient Britons was used, like the indigo of the American Indians, to dye the skin and hair. Complex and difficult though the art of dyeing with Indigo may be, it is thus more intimately associated with the early human race than any other known dye or pigment. And in India it would appear that a far larger number of plants are regularly resorted to as sources of this dye than is the case with almost any other country in the world. In addition to ***Isatis*** met with on the north-west alpine tracts and Afghanistan, mention has, for example, to be made of the *rum* of Assam and Central China (***Strobilanthes flaccidifolius***, p. 1051); of the *ryom* (***Marsdenia tinctoria***, p. 774), found in the north-eastern tracts, a plant closely allied to the original indigo plant of Java; of an indigo plant (***Tephrosia purpurea***) well known in Bombay and Rajputana and closely allied to one of the indigoes of the Niger and Egypt; of the *Nerium* or *pala* indigoes (***Wrightia tinctoria***, Area Shifted.

p. 1131) of South India, the plant which would appear to have been used prior to the introduction of the species of *Indigofera*; of the indigoes of Burma (such as *Gymnema tingens*); of Cochin-China (*Spilanthes tinctoria*); and of North China and Siberia (*Polygonum tinctorium*). These and many others are plants which have been, or are being, used as sources of this particular dye in some parts of India. Is it to be wondered at, therefore, that the early records of the industry leave on the mind of the student the suspicion that the plant used in early times was, in all probability, not always the indigo of to-day? Not only has the modern industry shifted from Agra and Gujarat to Bengal, but the plant grown has been changed completely. [*Cf.* Joret, *Les Pl. dans L'Antiq., etc.*, 1904, ii., 271, 345-6.]

It may serve a useful purpose to quote in some detail and in sequence of date a few of the more instructive accounts of the indigo industry of India. It is thus contemplated to concentrate attention on the Indian issues, and if possible to exemplify from past historic records and scientific experience the directions of possible economy and improvement.

Cultivation in Bombay.

Agra.

Historic Records of Indigo.—*Periplus of the Erythræan Sea* (80 A.D.) (McCrindle, transl., 17, 109) speaks of indigo as exported from Barbarikon, a Skythian town on the Indus and the port for the metropolis—Minnagar. Marco Polo (1298) gives a grotesque, though accurate, account of the Native indigo industry as seen by him at Coilum (Quilon). "It is made of a certain herb which is gathered, and (after the roots have been removed) is put into great vessels upon which they pour water and then leave it till the whole of the plant is decomposed. They then put this liquid in the sun, which is tremendously hot there, so that it boils and coagulates, and becomes such as we see it. (They then divide it into pieces of four ounces each, and in that form it is exported to our parts)." Athanasius Nikitin (1468) (a Russian traveller) speaks of Kanbat (Cambay) where the indigo grows. Vasco da Gama (1498), Varthéma (1503), and Barbosa (1516), who all visited Gujarat and the west coast of Bombay, make no mention of indigo, from which circumstance it may be inferred to have been a comparatively unimportant industry. Garcia de Orta (1563), however, gives a short account of its cultivation and manufacture in Western India. He calls it the *Anil* of the Arabs and Turks, the *gáli* and *nil* of Gujarat, and remarks that it is tested for purity by burning, when there should be no sand in the residue, and by being so light that it may float on water. Acosta (*Tract. de las Drogas*, 1578, 406) describes the *Anil* of Gujarat. Barrott (1584) mentions indigo from Zindi and Cambaia. It is not apparently referred to in Baber's *Memoirs*, 1519-25, and is but mentioned in the *Ain-i-Akbari*, 1590 (Gladwin, transl., ii., 28, 41), as produced at Agra. Linschoten (*Voy. E. Ind.*, 1598, i., 61-2; ii., 91) speaks of "*Annil*" or indigo as it "groweth only in Cambaia and is there prepared and made ready, and from thence carried throughout the whole world." So again, he says, "*Annil* or indigo by the Guserates is called *gali*, by others *nil*: it is a costly colour and much caryed and trafiqued into Portingall: it groweth in India in the kingdom of Cambaia: the hearbe is very like rosemary, and is sowed like other hearbes, and when the season serveth is pulled and dryed and then made wette and beaten, and so certain dayes after dryed againe and then prepared." (In passing it may be here pointed out that the passage just quoted implies that at the time Linschoten wrote, the dry-leaf process was pursued in Gujarat.)

Indication of Indigofera.

Finch's Account.

François Pyrard (*Voy. E. Ind.* (ed. Hakl. Soc.), 1601-10, ii., 359, etc.) repeats the account given by Linschoten. In *The First Letter Book of the East India Company*, 1605 6, Birdwood and Foster quote a letter of instructions to purchase Indico of Lahar (Lahore), Serchis (Sarkhej, 5 miles S.W. of Ahmedabad) and Belondri (? Ballabi, a village 20 miles from Bhavanagar). Finch (*Travels in India*, in *Purchas' Pilgrimes*, 1607, i., 429) affords the first definite conception of the indigo industry of India, or rather of Agra and Fatehpur Sikri, and from him perhaps dates the conception of the plant being an *Indigofera*:—"The herb *Nill*, groweth in form not much unlike Cives or Cich-pease, having a small leafe like that of *Sena*, but shorter and broader, and set on a very short

Grows for Three Years.

Beating the Liquid.

Balls dried in the Sun.

foot-stalke, the branches hard and of a woodie substance like unto broome. It usually groweth not above a yard high, and with a stalke at the biggest (which is at the third yeare) not much exceeding a man's thumbe. The seed is included in a small round codde about an inch long, resembling *Fœnigrœcum*, save that it is more blunt at both ends, as if it had been cut off with a knife. It carryeth a small flower like that of Heart's-ease, the seed is ripe in November, and then gathered. The herb once sowne dureth three years, being cut every year in August and September after the raines. That of one yeere is tender and thereof is made *Notee*, which is a weighty reddish *Nill* sinking in water, not come to his perfection : that of the second yeere is rich, and called *Cyeree*, very light and of a perfect violet colour, swimming on the water : in the third yeere the herb is declining and this *Nill* is called *Catteld*, being a weightie blackish *Nill*, the worst of the three. This herbe being cut the month aforesaid, is cast into a long cistern, where it is pressed down with many stones, and then filled with water till it be covered, which so remaineth for certain dayes, till the substance of the herbe be gone into the water. Then they let the water forth into another round cistern in the midst of which is another small cistern or center: this water being thus drawn forth, they labour with great staves, like batter or white starch, and then let it settle, scumming off the clear water on the toppe : then labouring it afresh, and let it settle again, drawing forth the clear water, doing this oft, till nothing but a thick stubstance remaine : which they take forth and spread on cloth, to dry in the sunne : and being a little hardened, they take it in their hands and making small balls, lay them on the sand to dry (for any other thing would drink up the colour), this is the cause of the sandy foot. So if rain fall, it loseth his colour and glosse and is called *Aliad*. Some deceitfully will take of the herbe of all three crops, and steepe them altogether, hard to be discerned, very knavishly. Four things are required in *Nill* : a pure graine, a violet colour, his glosse in the Sunne, and that it be dry and light, so that swimming in the water, or burning in the fire, it cast forth a pure light violet vapour, leaving a few ashes."

Roe's Account.

Oil mixed with Indigo.

Sir Thomas Roe (*Embassy to the Court of the Great Mogul*, 1616, i., 270) speaks of the rise in price of Agra indigo and of the sales being effected under *churls* (or fardles). The *churl* of Biana indigo has been computed as being equal to six maunds. Of the same year, Foster (*E.I.C. Letters*, iv., 241) records the following curious passage:—" Indigo is made thus. In the prime June they sow it, which the rains bring up about the prime September : this they cut and it is called *Newty*, and is a good sort. Next year it sprouts again in the prime August, which they cut and is the best indigo, called *Jerry*. Two months after it sprouts again, which they cut and thereof they make the worst sort ; and afterwards they let it grow to seed and sow again. Being cut, they steep it 24 hours in a cistern of water ; then they draw it into another cistern, where men beat it six hours forcibly with their hands till it become blue, mixing therewith a little oil ; then, having stood another day, they draw off the water and there resteth settled at the bottom pure indigo (which some to falsify mix with dirt and sand) ; which they dry by degrees, first in cloths till the water be sunk from it and it be curdled ; afterwards they dry it in round gobbets."

"*Newty*" and "*Jerry*" Crops.

Dry-leaf.

Mandelslo's Account.

Here we have a distinct reference to the indigo plant having been grown for two or three years without being uprooted or re-sown. H. A. Bailey of Etawah describes the system that exists to-day in Shahabad, which in some respects resembles the old method (*E.I.C.*, *l.c.* iv., 356). This system has long since been abandoned in the indigo districts proper, the change possibly denoting new stock, when that system was unnecessary. The "*Newty*" crop is doubtless the "*Notee*" of Finch, both words being probably derived from *naudhá* (the young plant); and "*Jerry*" being the "*Cyeree*" of Finch, both words doubtless being derived from *jarí*, which would mean "sprouting from the root" (*jar*). With the change in the system of cultivation both these terms have become disused and forgotten. Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.*, 1638, 83–4) gives a most curious account of the cultivation and manufacture of indigo in Gujarat (Ahmedabad) which (as with Linschoten's account above) involves acceptance of belief that the method of manufacture pursued was that known as the Dry-leaf. His description of the flower being like that of a thistle was either a mistake (the plant being confused by Mandelslo with *Carthamus*) or the plant used at that time was not *Indigofera*. The former seems the more plausible explanation. The passage may be usefully quoted in full :—" The best indico in the world comes from about Amadabath from a village called Chirchees, whence it derives the name. The herb of which they make it is like that of yellow Parsnip, but shorter, and more

Adulteration.

Mixed with Oil.

bitter, sprouting forth into branches like a Reed, and growing in kind years, six or seven foot high : the Flower is like that of a thistle, and the seed like that of *Fenu-greek*. It is sown in June and cut in November and December. It is sown but once in three years, and the first year the leaves are cut off within a foot of the ground. The stalks are taken away, and the leaves are set adrying in the Sun, and that done, they are set asoaking, for four or five dayes, in a stone-trough, containing about six or seven foot water, which is ever and anon stirred, till such time as the water hath suckt out the colour and virtue of the herb. That done, they let out the water into another trough, where they suffer it to settle for one night. The next day, all the water is taken away, and what is left in the bottom of the trough is strained through a coarse cloath, and is set adrying in the Sun. And this is the best Indico ; but the country people adulterate it, by mixing therewith a certain earth of the same colour. And whereas the goodness of this Drug is discovered by its lightness, they have the cunning to put a little Oyle into it, to make it swim upon the water."

Rotation.

"The second year, the stalk which was left the year before shoots forth other leaves, but they are not so good as those of the first. Yet is this preferred before *Gyngey*, that is, wild Indico. It is also the second year that they suffer some part of it to grow up to seed. That of the third year is not good, and consequently not sought after by foreign Merchants, but is employed by the inhabitants of the country in the dyeing of their Cloaths. The best Indico is almost of a violet colour, and hath somewhat of its smell, when burned. The *Indosthans* call it *Anil ;* and after it hath been in the ground three years, they suffer the Land to lye fallow for one year ere they sow it again."

Terry's Account.

Built Vats.

Tavernier's Account.

Bengal Indigo.

Hove's Account

Rheede' Account.

Terry says of Gujarat in 1622, "The indico we bring thence is good, and a rich commodity. It is there made of leaves not bigger than those of our Gooseberry bushes, and the shrubs that bear those leaves are about their bigness. Those leaves they slip off from the small branches of those bushes, which grow with round and full heads without prickles. The leaves thus stripped off, are laid in great heaps together certain days till they have been in a hot sweat ; then are they removed and put into very great and deep Vessels fill'd with sufficient quantity of water to steep them in, where they leave their blue tincture with their substance ; this done, the water is drained out into other exceedingly broad, but very shallow Vessels or Vats, made of Plaister (like to that we call Plaister of Paris) which will keep in all the Liquor till the hot Sun in short time extracts the moisture from it ; and then what remains in the bottome, is a Cream about one quarter of an inch thick, which suddenly becomes hard and dry, and that is our *Indico*, the best sort whereof comes from *Biana*, near unto *Agra*, and a coarser sort is made at *Cirkcese*, not far from *Amadamaz* ; about which two places, are a very great number of those shrubs planted, which bear those leaves." Could the plant have been *Indigofera* ? The passage is taken from Petro Della Valle (*Travels* (ed. Hakl. Soc.), 1665, 367). Francis Bernier (*Travels*, 1656, 283) makes mention of the *Anil* or *Indico* of Delhi. Tavernier (*Travels*, 1670 (ed. Ball), ii., 8-12) of all the early European authors gives perhaps the most detailed and accurate account. He discusses the production in Gujarat (Sharkej, Ahmedabad, Surat, and Broach), of Golconda, of Agra (Biana, Indoua and Corsa) and of Bengal. He then adds that the Dutch Company convey the Bengal dye to Masulipatam, and that the Bengal and Gujarat indigoes can be purchased at 30 per cent. less than that of Agra. The reference to a Bengal indigo at the date in question is certainly remarkable. His account is too lengthy for quotation, but it will richly repay perusal. He describes the steeping vats, the use of oil, and the drying in the sun discussed by other travellers. Hove (*Tours in Gujerat, etc.*, 1787, 107–8) gives full particulars of several plantations visited by him. The plant, he says, was usually sown in the beginning of the rains and suffered to grow for two seasons. The first crop is cut at the end of the rains and the last about March or April. So late as 1820 we read of indigo planting having existed in Gujarat, and a number of unused pits near old villages and among the buried cities of the Satpuda mountains bear silent testimony to the former important industry of indigo manufacture. Rheede (*Hort. Mal.*, 1678, i., 101-2, t. 54 ; ix., t. 30) gives a brief account of the indigo industry of the Malabar coast and furnishes two pictures, which thus leave no doubt that the plant or plants to which he alludes were species of *Indigofera*. Sir W. Hedges, during his agency of Bengal, wrote a diary, 1681, which deals with his tours of inspection through Hughli, Malda, Dacca, Balasore, etc., and discusses the articles of merchandise there met with. It is noteworthy that he makes no mention of Indigo. We are thus led to believe the cultivation and manufacture of indigo, which in time became one of the most important of Bengal industries, could not have existed in the districts visited by Hedges. But we learn it was established in Tirhut originally by the Dutch, for we read of their having owned the Singia concern in 1791. It would seem, however, from Tavernier's allusion to Bengal indigo that a Native industry had existed a little earlier. But shortly after Hedges' report a change was effected, owing to a Resolution of the Directors of the East India Company. European planters were brought from the West Indies to Bengal to undertake the cultivation of indigo. In 1790 indigo factories were accordingly established in Jessore. Hardly, however, had the industry been thus organised when it was ruined, for we read in Sir W. W. Hunter's *Imperial Gazetteer of India* that "English indigo planters have forsaken the districts of Hughli, the 24-Parganas, Dacca Fairdpur, Rangpur, and Pabna, now dotted with the sites of ruined old factories." The industry had thus been established and ruined in Bengal.

It is perhaps hardly necessary to continue this series of quotations much further by supplying a correspondingly detailed selection regarding Africa, Egypt, the West Indies, America, etc. The following may, however, be of value to persons interested in the history of indigo manufacture :—

Rochefort's Account.

Pomet's Account

Olive Oil.

Use of Vats.

Churning Contrivance.

Straining.

Père Labat's Account.

Rochefort (*Hist. Nat. et Mor. des Isles Antilles*, 1658, 98) speaks of the indigo being produced from a plant which rises only about a foot and a half from the ground. It has small leaves of a light green colour which turn yellow. The flower is reddish. It grows from seed. Its odour is very disagreeable, unlike the Madagascar species, which has small flowers of a whitish-purple colour and a pleasant smell. Pomet (*Hist. Gen. des Drog.*, 1694, 151–6 ; also Engl. ed. with annot. from Lemert and Tournefort, 1712, 89–91) gives a brief description and an engraving of the plant, and these leave no doubt that it was an *Indigofera*. It is sown, he tells us, by the Americans in holes a foot distant, and in two months' time the plant will be ready to cut, and if left for three months will yield both flower and seed. "Indigo is a meal or flour," he observes, "made by means of water and oil-olive out of the leaves of the *anil* or indigo plant ; for there is a difference betwixt that made of the leaves and of the small branches. The choicest of the former sort is that which bears the surname of Sorquisse (*Sarkhej*)." "They cut the said herb with a sickle when the leaves begin to fall upon touching them ; and after they have stript them from the branches, they put them into sufficient quantity of water, which is in a vessel called the steeping Vat, then letting them infuse thirty-six hours ; after which they turn the cock in order to let the water run off, which is tinged of a green colour, inclining toward blue, into a vessel of the nature of a churn, which is worked by the labour of several men, by means of a Roullor or Turner of Wood ; the ends of which run pointed, and are hooped with iron ; this they work "till the said water abounds with a lather, then they cast into it a little oil-olive ; to wit, one Pound into such a Quantity of the Liquor as will yield seventy pounds of indigo, which is the quantity now sold in a barrel ; and as soon as the said oil is thrown in, the Lather separates into two parts so that you may observe a Quantity curdled as milk is when ready to break ; they then cease churning and let it stand to settle, which when it has done some time, they open the Pipe or Cock of the Churn, in order to let the water clear off, that the meal which is subsided may remain behind at the Bottom of the Vessel like clay or Lees of Wine. Having decanted it thus, they put it into straining Bags of Linnen to separate what water was left, then they convey it to the Chests or Boxes that are shallow to dry it, and being dried, it is what we call Indigo." Pomet furnishes (plate 35) an admirable picture of an indigo factory which shows the water tank, the steeping vat, beating vat and evaporating vat. The mechanical contrivance for churning or beating the liquid is also shown, but the author makes no reference in the text to his plate, and it would appear accordingly to have been copied from some still earlier author. Père Labat (*Voy. aux Isles de L'Amerique*, 1724, i., 90–9, t. 90) gives a long and interesting account of the indigo industry which was translated into English by Philip Miller and given in his *Gardener's Dictionary* (1st ed., 1731) under the name *Anil*, from the belief, apparently, that it was fully representative of the industry as a whole. But Labat deals very nearly exclusively with the indigo of Martinique, and his description, like that of Pomet, is more characteristic of the Antilles and the West Indies than of India proper. In two months' time, says Labat, the first crop of cuttings can be taken, and if the rain continues, subsequent

West Indies.

cuttings may be made every six weeks, and the plants continue to bear for two years.

Browne's Account.
Engine for Beating.
Use of Heat.
Edwards' Account.
Lunan's Account.
Lime.
Dried in the Shade.

Browne (*Hist. Jam.*, 1789, 302–5) describes two forms—the wild indigo and the Guatimala indigo. He views the wild as only the survival of a still earlier cultivation, the buildings of which often "remain very perfect to this day." Browne gives interesting particulars of the "best engine" seen by him for beating; this was in design much the same as some of the contrivances patented in India a century later. He is one of the first authors to mention the use of heat in drying the indigo. "The Magma or mud" is by some put into a cauldron and heated over a gentle fire, but not so far as to boil, and is then emptied into little "ozenbrick" bags to drain; by others it is not heated, but immediately put into the like bags to drain. Edwards (*Hist. British West Ind.*, 1793, ii., 280–8) speaks of three species of indigo, viz. the wild, the Guatimala, and the French. Of these the "French surpasses the Guatimala in quantity but yields to it in fineness of grain and beauty of colour." Lunan (*Hort. Jam.*, 1814, i., 419–26) gives a most instructive account both of the plant grown and the method of manufacture pursued in Jamaica, but quotes very largely from both Browne and Edwards. The plants are regularly laid in the steeper with the stalks upwards, which, he says, hastens the fermentation. None of these West Indian writers, let it be specially noted, speak of the dry-leaf process—the whole plant is carried at once to the steeping vats. After being beaten by various contrivances a little clear lime-water is gradually let in to augment and precipitate the *fæcula*. Too large a quantity of lime would render the indigo hard and of a greyish colour. The *fæcula* is placed in bags and allowed to drain; these are then placed within a press and the remainder of the water squeezed out. The dye is next removed from the bags, placed on a table, cut into square cakes and dried in the shade—the sun being regarded as hurtful.

East India Company.
Migration of Industry.
Tirhut Industry.
Severe Losses.
Direct Support.
Native Investments.

The East India Company published in 1836 a series of reports and letters regarding the indigo industry, the preface to which records (what may have been inferred from the above series of quotations) the migration from and return again to India of the industry. That work will be found of the greatest possible interest, and should be consulted for historic details. Mr. Minden Wilson has written in the *Indian Planters' Gazette* a series of graphic historic sketches of the introduction of Indigo in Bihar. From these it would appear that Mr. Grand, the husband of the lady who subsequently married Prince Talleyrand, was one of the founders of the industry. Wilson gives the dates of several concerns—Contai was opened out about 1778 and Singia in 1791; but the last mentioned, as already stated, originally belonged to the Dutch East India Company. These are representative, the Tirhut industry having been mainly established between 1778 and 1800. The Court of Directors of the East India Company sustained severe losses, however, by their endeavours to re-establish the Indian industry, though they obtained the satisfaction of knowing that they had been successful. In time they accordingly threw the traffic open to all, and hoped that their servants might find in indigo "a mode of remitting their fortunes to Europe which would be legal, advantageous and adequate." For twenty-two years (from 1780 to 1802) the Company directly supported the indigo industry and placed India once more in the foremost rank among the indigo-producing countries of the world. They, however, continued to make purchases of indigo for the purpose of remittances, and to ensure the supply they even made advances to the special factories that had contracted to sell their produce to the Company. About this time also it was recognised that the industry could not be regarded as successfully established in Bengal so long as it was exclusively held by the Anglo-Indian community. It was accordingly arranged that purchases should be made from, and advances given to, factories owned by Natives provided the security was "sufficiently respectable and the quality fit for the European market."

Recapitulation.
Western India.
Dutch East India Company.

But the story of the indigo industry is more entertaining historically and more pathetically instructive than that of almost any other Indian agricultural or industrial substance. The main facts may, therefore, be here briefly recapitulated:—There is abundant evidence in support of the belief that when Europeans first began to purchase and export the dye from India, it was procured from the Western presidency and shipped for the most part from Surat. It was carried by the Portuguese to Lisbon and sold by them to the dyers of Holland. It was the desire to secure a more certain supply of dye-stuff that led to the formation, in 1631, of the Dutch East India Company, and shortly after to the overthrow of the Portuguese supremacy in the East. The success of the Dutch merchants

Protection of Woad.

aroused the jealousy of Europe. The woad growers and merchants of Germany, France and England were threatened with ruin, and to protect them nearly every country passed edicts rendering the importation or use of indigo a criminal offence punishable by death.

Indigo and Woad.

England and Indigo.

Colonial Competition.

Cultivation in West Indies abandoned.

Re-establishment in India.

Troubles in Bengal.

Migration to Tirhut.

Chemical Discovery.

In 1608 England learned the art of indigo-dyeing, and in the reign of Queen Elizabeth its use was permitted along with woad. Curiously enough this mixing of woad with indigo survives to the present day, and to meet this demand a small amount of the woad is grown here and there over Europe, and even in England. The opposition to indigo was, however, so strong that it was again, on the pretext of being poisonous, prohibited, and in 1660 Charles II. had to procure dyers from Belgium to once more teach the English the art of using the dye. As already shown, the effect of the persistent export of the dye from India, conducted by the East India Company, had the effect of stimulating the Spanish, French, Portuguese and English colonists to make strenuous efforts to produce the dye in many countries outside India. And so successful were they that for a time they ruined the ancient Indian traffic. But Macpherson (*Hist. Europ. Comm Ind.*, 1812, 200) speaks of the East India Company having voluntarily given up the importation of indigo into England "in order to avoid a competition with the British Colonists in the West Indies and the southern provinces of North America. About the year 1747 most of the planters in the West Indies, particularly in Jamaica, gave up the cultivation of indigo in consequence of the high duty imposed upon it"; "the planters of Carolina and Georgia were never able to bring their indigo to a quality equal to that of Guatimala or St. Domingo." But political difficulties occurred with America and France, and at the same time sugar and coffee had proved even more profitable in the West Indies than indigo. The impetus was thus given for a re-establishment of the Indian traffic, and, as one of the many surprises of the industry, the province of Bengal was selected for this revival. It had no sooner been organised, however, than troubles next arose in Bengal itself through misunderstandings between the planters, their cultivators, and the Government, which may be said to have culminated in Lord Macaulay's famous *Memorandum* of 1837. This led to another migration of the industry from Lower and Eastern Bengal to Tirhut and the United Provinces. Here the troubles of the industry did not end, for, just as indigo had ruined "the Waid Herrn," so the researches of the chemical laboratories of Germany threatened the very existence of any natural vegetable dye. They first killed the maddar dye of Europe, then the safflower, the lac and the *al* dyes of India, and are now advancing rapidly with synthetic indigo, intent on the complete annihilation of the natural dye. Opinions differ on many aspects of the present vicissitude; meantime the exports from India have seriously declined, and salvation admittedly lies in the path of cheaper production both in cultivation and manufacture. These issues are being vigorously faced and some progress has been accomplished, but the future of the industry can scarcely help being described as of great uncertainty. The issue is not the advantage of new regulations of land tenure, but one exclusively of natural *versus* synthetic indigo.

Improvement.

Finance.

Economy.

Stock.

Rotation.

Manufacture.

IMPROVEMENT OF STOCK.—Sir Edward Law (formerly Finance Minister of India), in a letter to *The Pioneer* in December 1905, refers to his views regarding the future of the indigo industry:—"It would appear to be assumed," he says, "that because unfortunately the production of indigo continues to fall off, my belief in the possibility of recovery of the industry is a mistaken one. In my last budget speech in March 1904, I enumerated the following improvements as necessary to effect a reduction in the cost price of indigo and thereby secure a profit to growers and manufacturers:— (1) that the plantations should be placed on a sound financial basis, and cease to remain in a position where requirements for cash in seasons of dear money could only be satisfied by transferring profits from the pockets of the planters to those of the money-lenders; (2) economy in management; (3) selection of seed and propagation of the qualities yielding the highest percentage of indigotin and best suited to local conditions of climate and soil; (4) rotation of crops to obtain good profits from the land when not under indigo, and thereby reduce the cost of cultivation of the plant; (5) chemical improvements in manufacture." "When it can be stated that all the improvements I indicated as necessary have been carefully and persistently tried, and that still natural indigo cannot be made to pay, I shall with great regret have to admit that I have been wrong."

Improvement.

There would seem no doubt that each one of the conditions of improvement indicated by Sir Edward are of vital importance; and what is more to the point, hardly any of them have been successfully and completely investigated. A considerable advance would appear to have been attained recently by Bloxam, in his chemical studies of the dye. Leake commenced research into the races of the plant grown and the localisation of the dye within the plant tissue, but his studies were brought to a sudden termination, when on the threshold of possible practical results, through the severance of his connection with the Indigo Planters' Association. It is understood that a start has also been made by the new research station under the direction of the Inspector-General of Agriculture, from which much may indeed be expected in the future. The planters themselves, in their anxiety for alternative crops to be grown on the land when not under indigo, are concerned with an issue of great practical value.

Leake has obligingly furnished for this work a review of his own results and those of other workers in the path of indigo-plant improvement, the passages from which will be indicated by quotation marks.

Present Position.

Present Position of the Industry.—"It may be affirmed that the methods employed for the production of the dye are very crude. The fluctuations in the daily outturn are very large, and all attempts to control the yield have so far proved unavailing, if not prejudicial. This is only one way of confessing our ignorance of the steps of the process. So long as the planting community enjoyed a practical monopoly this inability to control was of little moment. A fall in the quantity of dye produced implied a corresponding rise in price. With the introduction of the synthetic product a short yield no longer meant enhanced price, and this fact, associated with a series of bad seasons, has reduced the margin of profit to a vanishing point. If natural indigo is to compete successfully with its synthetic rival, there is no longer room for the losses which the fluctuations above noticed necessarily involve. A study of the manufacture of indigo reveals how little at present is known of the chemical and bacterial changes involved. Until these have been worked out, little can be hoped for from improvements in the methods pursued. One fact alone is evident, namely that only a fraction of the latent dye-forming power is developed.

Practical Monopoly.

Dye-forming Power.

"For the present, therefore, the planters must look elsewhere to find relief from the severe competition of the synthetic product. The two lines that suggest themselves and which are, to a small extent, receiving attention, are the introduction of supplementary crops and the increase in the yield of plant per acre (cultivation) as opposed to the increase in the yield of dye per unit of plant (manufacture). The first of these falls outside the province of this article. The second falls naturally under two heads (1) improvement of the present plant ***I. sumatrana*** by seed control, etc.; (2) introduction of other and richer stocks.

"(1) For the same reason that the *mahai* (indigo manufacture) cannot profitably be altered at the present time, it is also impossible to progress in any process of selection of stock, and, as long as it remains impossible

Seed-producing Areas.

to estimate the dye-yielding capacity of the plant, this must remain so. This, however, does not afford the sole possibility for improvement. The migration of the cultivation of *I. sumatrana* has already been noted. With this migration has arisen a complete separation of the seed-producing districts, and at the present time it is no exaggeration to say that a planter does not know from what district his seed comes. Investigation has shown that the seed-producing area can be separated into two main divisions, each characterised by a very distinct type of plant. The first of these areas includes the Western Panjáb and Indus valley, and the plant here is stunted, flowers early, and possesses a very marked and characteristic alternate arrangement of the branches and leaves. The second area includes the Eastern Panjáb and the United Provinces, in which the plant is tall, bushy, and flowers late. Comparing these :—

Western and Eastern.

—	Western Area.	Eastern Area.
Yield of plant per acre	90 maunds	140 maunds
Leaf percentage..	62·5 „	54·4 „
Yield of leaf per acre	66 „	82 „

"Since the leaf is the main dye-yielding part of the plant, it is obvious that large benefits are likely to be derived from a limitation of the seed-producing area.

Java versus Bengal.

(2) "For some years attempts have been made to introduce other species of *Indigofera*; and that species which has yielded the most promising results is *I. arrecta, Hochst.* It must be borne in mind, however, that Java indigo does not fetch the price of good Bengal indigo, although the percentage of indigotin is very high in the former, and that this may mean a specific inferiority in the dye obtained from *I. arrecta*.

Hard Seed.

"A difficulty in obtaining a good germination has alone checked the general cultivation of this plant. The defect has, however, been traced to the large percentage—between 90 and 96 –of 'hard' seed. With the introduction of a seed-treating machine this difficulty has been removed and *I. arrecta* will probably be extensively cultivated" (Leake) (see p. 661).

Localisation of Indigo.

The Localisation of the Indigo-producing Substances in Indigo-yielding Plants.—The following is a brief abstract of the contents of the paper on this subject :—"Some attempts have been made to trace the function and place of the indigo-yielding substance in the plant metabolism. For instance, Molisch tentatively ascribes to it a position among the anabolic products, and attempts to establish a direct relation between its formation and the chloroplasts. His arguments are largely based upon the localisation of indigo when precipitated within the tissues. He traces a relationship between the chloroplasts and the grains of indigo thus precipitated. This relationship is difficult to uphold, as the present writer has endeavoured to show. The substance may be found in such tissues as pith, xylem-parenchyma, phloem, fibrous cortical tissue, epidermis and in embryonic tissue, even in the embryo sac. In chlorophyll-bearing tissues, it is difficult to trace any relationship between the chloroplasts and the precipitated grains of indigo. By this method of localisation it is impossible to bring conclusive evidence to prove the absence of a relation between the indigo-yielding substance and the chloroplasts. To establish such a relation other lines of investigation will have to be resorted to" (Leake).

Chloroplasts.

[*Cf.* Schunck, *Formation of Indigo Blue, Phil. Mag.*, 1885, x., 74; xv., 127; Goppert, *Bot. Zeit.*, 1871, xxix., No. 24, 399; Müller-Thurgan, *Landw. Jahrb.*, 1880, ix., 157–66; Molisch, *Sitzb. der Kais. Akad. Wiss. Wien.*, 1893, i., ciii., 269; *Zeitschr. des Allgem. besterr. Apoth-Vereines*, 1893, xlvii., 523; *Sitzb. der Kais. Akad. Wiss. Wien*, 1898, i., cvii., 747; *Sitzb. der Kais. Akad. Wiss. Wien*, 1899, i., cviii., 479; *Berichte der Deut. Bot. Gesell.*, 1899, xvii., 288; Bréaudat, *Comptes Rendus*, 1898, cxxvii., 769; Beijerinck, *Proc. Roy. Acad. Sc. Amsterdam*, 1899, ii., 120; 1900, ii., 495; iii., 101; Hazewinkel, *Proc. Roy. Acad. Sc., Amsterdam*, 1900, ii., 512; Plowright, *Journ. Roy. Hort. Soc.*, 1901, xxvi., 1; Bergtheil, *Journ. Chem. Soc. Trans.*, 1904, lxxxv., 877; Bloxam and Leake (with the assistance of Finlow), *Acc. Research Work in Indigo* (Calc., The Bengal Secretariat Book Depôt, 1905); Mollison, *Indigo Seed Select., Agri. Journ. Ind.*, 1907, ii., pt. iii., 296–7.]

CULTIVATION.

Cultivation.
Occupation of Soil.

Soil Improvement.

Area and Yield.

Area and Production.—Perhaps one of the most surprising features of indigo cultivation is the variation of the period of occupation of the soil. In some localities the crop is obtained in three months from time of sowing, and from this as a minimum up to as much as eighteen months every possible period is manifested. Speaking generally it may be said that the system of taking several cuttings a year and allowing the plant to occupy the soil for two or even three years seems to have been discontinued—possibly as a consequence of the change that has taken place in the stock now chiefly grown. In the upper provinces, especially where irrigation prevails, indigo occupies the soil in annual rotation with wheat or rice, and is regarded as a catch crop that greatly improves the soil. So much is this the case that indigo has often been recommended as a green manure to be grown temporarily and ploughed into the soil. But in Lower Bengal, on the other hand, the spring-sown crop calls for attention at the very time of the principal rice sowings, and it is therefore an unpopular crop with many cultivators. But a far more serious difficulty has arisen in the production of artificial indigo. The seriousness of this aspect may be at once exemplified by the figures of area and yield. In 1892–3 the area in all India was 1,218,766 acres and the yield 179,056 cwt.; in 1894–5 the corresponding figures were 1,688,042 acres and 237,494 cwt.; in 1896–7, 1,608,901 acres and 168,673 cwt.; in 1898–9, 1,010,318 acres and 139,320 cwt.; in 1900–1, 990,375 acres and 148,029 cwt.; in 1902–3, 645,511 acres and 79,207 cwt.; in 1904–5 the area was 473,757 acres and the outturn 56,200 cwt. Thus in twelve years the area under the crop and the yield decreased to one-third their former magnitude. The most recent forecasts indicate that the area decreased still further in 1905–6, viz. to 583,600 acres with a yield of 46,500 cwt., but the estimated area for 1906–7, namely 452,800 acres, has shown a slight improvement in yield of dye—69,700 cwt.

Land Tenure.—"It is impossible, in the space at disposal, to do more than touch upon the system of land tenure. There are commonly three systems throughout the indigo district of Bihar at present under European control. In the first of these the planter is the absolute possessor of the land, known as *zerat* lands. In the second, as the result of the lease by the *zamindars* to the planters of certain villages, the factory claims some portion—usually two to three *cottas* per *bigha*—of the highlands for the cultivation of indigo. The portion assigned for indigo is usually changed every two or three years. In both these cases the cultivation is effected by labour hired by the factory. In the third, the *raiyat*, under no compulsion, puts a portion of his land into indigo and sells to the factory the plant—either on a valuation of the standing crop or measurement of the amount cut.

" The area in which the cultivation of indigo reaches the highest development is Northern Bihar, the chief districts of which are Champáran, Muzaffarpur, Darbhanga and Saran. In these districts the concerns are entirely under European management. In other areas the specialisation in the methods of cultivation and manufacture is not carried to the same extent. It will be sufficient, therefore, to refer in detail to this area alone, and in the case of other areas to draw attention merely to the points of divergence " (Leake).

D.E.P., iv., 400-6. Bengal.

BENGAL.—Area and Production.—In 1904–5 the total area under the crop, according to the *Agricultural Statistics*, amounted to 223,100 acres, and the outturn to 24,300 cwt. Cultivation reaches its highest development in Northern Bihar, the chief districts of which are Champáran, which in 1904–5 had 84,000 acres; Muzaffarpur, 35,000 acres; Darbhanga, 32,900 acres; and Saran, 18,000 acres. The final forecast for Bengal in 1906 estimates the total area as 137,800 acres and the yield as 1,323,400 lb. (11,816 cwt.). By way of contrast it may be added that the area devoted to the crop in Bengal during 1894–5 was 629,100 acres, which yielded 104,485 cwt. of dye.

Areas.

Bihar.—" As cultivation is at present practised, indigo forms a ' 16-anna ' crop. Preparation of the land commences at the end of the rains early in October, as soon as the land is cleared of the previous crop. It is thoroughly ploughed and finally levelled by the application of the *choki* or *hanghar*—a log of wood with the lower surface flat or hollowed, drawn by two or four bullocks. Usually the land is again ploughed and levelled or ' compacted ' after a few days—a process which may be repeated as many as four times. In the intervals between the ploughing, gangs of coolies with short sticks are sent over the land. These men collect the stumps of the previous crop, weeds and such like matter, thus clearing the land, and at the same time use their short sticks to break down any clods.

Ploughing.

" The whole of this process is aimed at reducing the surface soil to a state of fine division which will admit a further compacting to be readily effected. It is clear, therefore, that the extent to which the land is alternately ploughed and ' *choki-ed* ' will depend on the nature of the surface soil. In the high, light (*sumbe*) lands a relatively small number of ploughings will be sufficient; while in the low-lying clay (*mattyar*) lands, a greater number will be required before a sufficiently fine texture is obtained. When the soil is reduced to a sufficiently fine state of division, the plough is no longer used and the *choki* is only applied at intervals—two or three times a month until the time of sowing.

" The reasons for the adoption of these somewhat intricate processes will become plain when certain peculiarities of the soil and climate of these districts are explained.

Seasons.

" Indigo is sown at the commencement of the hot weather—late February or early March. Since the end of the previous rains—early October—only an inappreciable amount of rain has fallen, for in these districts the average total rainfall from November to May, inclusive, is under three inches. The planter, therefore, is entirely dependent on the moisture retained by the soil from the previous rains, both for the germination of the seed and for the support of the young plant until the break of the rains in June. It will be readily understood that, with the temperatures and low atmospheric humidity which prevail at the time of sowing, the surface soil would soon lose all moisture unless this be constantly replenished by

Rain.

Soil.

a supply from the deeper layers. Throughout the area the soil consists of an extremely fine alluvial deposit which extends down to and below the water-level—20 feet approximately. It is this unusual condition which makes a rapid capillary movement of water possible. Unless, then, the superficial four or five inches which have been disturbed by the plough are compacted to an extent which will allow the capillary rise of water to take place with a degree of rapidity sufficient to keep pace with the evaporation of moisture caused by the sun's heat, germination and subsequent growth of the plant will be impossible. It is to produce the necessary degree of compactness in the superficial soil that the above processes are adopted.

Temperature.

"Throughout this period—November to February inclusive—the lands are kept scrupulously 'clean' by constant weeding. Sowing, as already stated, usually commences in late February or early March. The exact date is dependent chiefly on the temperature, and it is the usual custom to wait till a night temperature of 60° is recorded. Once sowing is commenced, it is carried on with the utmost speed possible. Under the most favourable conditions the increasing day temperature will soon deprive the superficial soil of its moisture, and it is necessary—if the plant is to survive—that it shall have developed a sufficient length of root to be no longer dependent on such moisture. The seed is sown by means of drills, each drawn by two bullocks. Briefly, they consist of a trough, containing the seed, into which small wooden wheels dip. When the drill is in motion these rotate and pick up three to four seeds by means of shallow holes cut at regular intervals in their circumference. The seeds are thus carried forward and dropped down a slot, by which they are guided into a shallow furrow formed by a share situated in front of the slot. Each drill has six shares, corresponding to six wheels set at regular intervals, and thus sows six lines. As soon as the seed is sown a light *choki* is passed over the field and the seed is thus brought into intimate contact with the moist soil at a depth of about one inch from the surface.

Drill Sowing.

Seed to Acre.

"At the present time 8, 12 and even 20 seers (40 lb.) are sown per *bigha* (seven-eighths acre). There is no doubt that this is excessive, and it is difficult to understand how the practice has arisen. It is quite possible, with good seed, to obtain a yield in no way inferior to that normally obtained when using only four seers (8 lb.) per *bigha.* During the hot weather, growth is slow, but with the break of the rains this rapidly increases. The commencement of cutting depends to a large extent upon the date at which the rains break, but usually takes place about the middle of June. The low-lying crops are first cut, both because the more abundant moisture has given greater growth and because delay in cutting causes considerable risk of loss from sudden flooding. Two crops are normally obtained except when the plant is growing in the river-bed, where the rise of the river renders only one possible. These two cuttings are known respectively as the *morhun* and *khunti* cuttings. The crop is entirely hand-cut, and the cut plant is loaded into bullock carts and dispatched to the factory with the least delay possible. Immediately after the *morhun* crop is cut the land is ploughed. This, without damaging the crop, renders the surface open and uneven, and subsequent rain is retained in greater abundance. After the second cutting the land is ploughed and sown with a *rabi* crop or prepared, as before, to receive indigo in the following season. On arrival at the factory the carts are weighed, and the weight of plant is obtained approximately by difference."

Season of Cutting.

Two Cuttings.

Bengal.

Lower Bengal.—"The chief crop of indigo in Lower Bengal is obtained from the annually inundated tracts of land. The seed is usually sown broadcast upon the muddy banks left by the retreating water during the early part of October. In the case of the higher lands only is the plough used and the land, to a certain extent, prepared. The crop is cut in the following June and July" (Leake).

Two Crops.

In the districts of Bihar south of the Ganges, Patna, Gaya and Shahabad, the system of cultivation is closely allied to that pursued in the United Provinces. The soil is non-retentive of moisture, and the sowings are carried on chiefly during the rainy season in July, August, and September. The early rainy-season sowings are called *asarhi*, and the crop from these is cut in September and October. The later sowings continue to grow throughout the year and are reaped in July and August, when the crop is known as *khunti*, but that name is also applied to the second year's crop from the early sowings.

[*Cf.* Montgomery Martin, *Hist. E. Ind.*, 1838, ii., 866-9; iii., 248-57; Taylor, *Topog. and Stat. Dacca*, 1840, 132, 135-6; Westland, *Rept. Dist. of Jessore*, 1874, 135-6, 197, 211, app. iii., vii.-viii.; McCann, *Dyes and Tans Beng.*, 1883, 93-126; Grierson, *Bihar Peasant Life*, 1885, 243-4; Reid, *Cult. and Manuf. of Indigo*, 1887, 74-80, 103-14; Banerjei, *Agri. Cuttack*, 1893, 105-6; Voelcker, *Improv. Ind. Agri.*, 1893, 257-65; Rawson, *Cult. and Manuf. of Indigo in Beng.*, in *Planters' Gaz.*, July 29, 1899, 155-6; Aug. 5, 189; Aug. 12, 219-20; Aug. 19, 252; *Imp. Inst. Journ.*, Aug. 1899, 208; Rawson, Gardner & Laycock, *Dict. Dyes, Mordants, etc.*, 1901, 172; Mukerji, *Handbook Ind. Agri.*, 1901, 411-6; *Admin. Rept. Beng.*, 1901-2, 27-9; *Java Indigo*, in *Agri. Journ. Ind.*, 1906, i., pt. ii., 170; *Germination of Java Indigo in Bihar*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 262-3.]

D.E.P., iv., 408-9.
U. Prov.

UNITED PROVINCES.—Area and Production.—The area in 1904-5 was 107,516 acres: 98,695 acres in Agra and 8,821 in Oudh. The estimated outturn was 8,000 cwt. These figures show a great contraction on those of the previous year. The chief districts in Agra are ordinarily Aligarh, Azamgarh, Balandshahr, Etah, Cawnpore, Mainpuri; and in Oudh, Fyzabad. The final forecast for 1906-7 shows a still larger reduction to 40,374 acres: viz. 34,809 in Agra and 5,565 in Oudh. This represents a decrease of 75·2 per cent. on the average area of the years 1900-4, and of 83·5 on the average for 1895-1904.

Areas.

Seed Supply.

Commenting on these provinces, Leake says, "In the districts forming the west of the United Provinces and the east of the Panjáb, the cultivation of indigo for dye is practically extinct. The plant is, however, still grown to supply seed to Bihar. The seed is sown broadcast after the land has been irrigated and ploughed during March and April, and in those districts where dye is manufactured the plant is ready to be cut in August, but is left in the ground till December if seed is required. The process of dye manufacture, where practised, is essentially similar to that of Bihar." According to Duthie and Fuller (*Field and Garden Crops*, 1882, i., 43-50, t. xii.) it may be sown either in spring or at the commencement of the rains. In the first case it is called *jamowa* or *chaiti*, in the second *asarhi*. *Jamowa* indigo is ready to cut in August, *asarhi* a month later. Land under *jamowa* is as a rule ploughed up immediately the crop is cut; *asarhi* indigo is left in the ground till the following rains, when it springs up again and yields a *khunti* rop. Generally it is sown alone, though occasionally mixed with *juár* (*Sorghum vulgare*) or *arhar* (*Cajanus indicus*), and is surrounded with a border of castor or *san* (hemp). A loam is prepared; but where copious irrigation is possible, much of the cultivation is on the

Two Crops.

Mixed Crops.

lightest possible sand. Four ploughings are held advisable, though frequently in canal-irrigated districts the land receives only one. For *jamowa* indigo the ground must be watered before ploughing, while the *asarhi* fields are not ploughed till softened by the rains. The crop must be kept free of weeds, and two weedings at least are required. The cost of cultivating an acre of *jamowa* indigo, to be cut in August and followed by a *rabi* crop, is estimated at Rs. 15-7a.

Cost.

[*Cf.* Atkinson, *Gaz. U. Prov.*, 1875, ii., pt. i., 378–9, 423–4, 472–6; 1876, iii., pt. ii., 236, 307–10, 463; 1876, iv., pt. i., 93–4, 251; Wright, *Mem. Agri. Cawnpore*, 1877, 28–30; Buck, *Dyes and Tans*, 1878, 1–12, 9–94; Reid, *Cult. and Manuf. of Indigo*, 1887, 81–9, 115–21; *Dist. Gaz. U. Prov.*; *Settl. Repts.*]

D.E.P., iv., 410-1. C. Prov. and Berar.

CENTRAL PROVINCES AND BERAR.—Area and Production.—Only 110 acres were reported in 1904–5 as under indigo, these being in the districts of Buldana, Hoshangabad, Narsinghpur and Chanda. In Akola the seed is sown about the middle of the rainy season or latter half of July, and the plant is ready for use in October or November, when the flowers begin to form. [*Cf.* Sule, *Monog. Dyes and Dyeing, Berar*, 1896, 2.]

D.E.P., iv., 409-10. Panjáb.

PANJÁB.—Area and Production.—The estimated area in 1904–5 was 53,000 acres, and the yield 9,900 cwt. The large interest in seed cultivation accounts apparently for the disproportion of yield to acreage. The most important districts are Multan, Muzaffargarh, Dera Ghazi Khan and Rohtak. The final forecast for 1906–7 estimates the area at 62,300 acres, as against 67,500 in 1904–5. This total is shown to be 19·3 per cent. below the decennial average. The recent effort by the planters themselves to produce specially improved new seed could have had no other consequence than to disturb and possibly curtail the demand for Native seed. The following are the returns of seed production in the Panjáb for the past four years:—1904, 1,673,800 seers; 1905, 1,785,000 seers; 1906, 3,227,600 seers; and 1907, 1,248,900 seers.

Areas.

Seed Production.

"The easterly districts of the Panjáb should be considered in conjunction with the United Provinces. In the west, however, in Multan, Dera Ghazi Khan and Muzaffargarh, the methods are very primitive, and the market supplied is the purely Native trade across the north-west frontier. The plant is sown on irrigation, and hence the date of sowing depends on that of the opening of the canals—usually during May. By September the crop is ready to be cut, after which the plant may be ploughed up or left for a second, and, sometimes, even a third, year." "Lands subject to river inundation are considered unsuited; in other words, a prejudice exists against over-inundation. The land is prepared during the cold season after the winter rains, and sowing takes place from March 1 to May 15. The field is first flooded and the seeds scattered broadcast on the water. Irrigation is given every third day till the plants are about a foot high, then every eight or ten days" (Leake). [*Cf.* Morris, *Cult. and Manuf. Indigo in Mooltan*, *Gaz. Mooltan Dist.*, 1883–4, app. A, 161–6; *Panjáb, Dist. Gaz.*]

Sown with Irrigation.

Seasons.

D.E.P., iv., 410-1. Rajputana and Central India.

RAJPUTANA AND CENTRAL INDIA.—Small quantities are grown in Ajmir and in the Native States of Jaipur, Marwar, Gwalior and Tonk. In Ajmir the seed is sown broadcast in the month of June or as soon as the rains set in. When the young plants are above ground the grass is weeded out by a process of hand-hoeing. Reaping commences about October.

D.E.P., iv., 411-3. Bombay.

BOMBAY AND SIND.—Area and Production.—The late Mr. E. C. Ozanne, then Director of Agriculture, Bombay, wrote in his Annual Report (1885–6, 36–7) that—"In the 16th and 17th centuries, indigo, partly of

Early Production. Modern Traffic. Mixed Crop.

local growth and partly brought from Upper India, was one of the chief exports of Gujarat. Towards the close of the 18th century (1777) the cultivation, chiefly for local use, would seem to have been on a very considerable scale. But in the early part of the present century it again fell off and in 1827 had almost altogether ceased. At that time, prices were high and the demand was strong." The attempt then made to resuscitate the industry, however, failed, and " indigo has never again become a product of any importance." In an official letter of date 1889, Ozanne, however, speaks of the indigo cultivation of Bombay having been 4,182 acres. In 1904–5 there were only 806 acres under the crop. The following account of the cultivation in Western India is an abbreviation from Mollison (*Textbook Ind. Agri.*, iii., 279–83). The best crops are grown on *gorádu* soil (deep sandy loam). In the Deccan, medium black soils of fair depth are deemed most suitable. The crop is grown in the *khárif* (rainy) season. " Thorough tillage and a liberal application of manure are necessary. Well-rotted manure in a dressing of twenty cart-loads per acre should be given in May. The plough and harrow should be used after the first fall of rain to prepare a clean, smooth seed-bed. The crop is either sown alone or with subordinate rows of cotton. One row of cotton may alternate with two of indigo. When sown alone, the rate is 12 to 15 lb. seed per acre. The seed should be drilled if possible in June in rows 18 inches or less apart and the drill should be worked near the surface, so that the seed is not buried too deeply. The crop should, after the seedlings are well up, be intercultured two or three times with the bullock hoe and be once hand-weeded with the weeding-hook (*khurpa*). The first cut is ready in September–October. With favourable late rain, a second cut may afterwards be obtained without irrigation."

Sind.

The area in 1904–5 was in Sind 5,621 acres, chiefly located in Hyderabad, 3,985 acres, and Sukkur, 1,404 acres. After the land has been weeded and moistened during the inundation season in May and June, it is ploughed two or three times and the seed sown broadcast. When the plants have germinated, they are watered once a week, and this is continued till September, when the crop is ready to be reaped. A second year's crop is raised after cutting by frequently watering the old plants. [*Cf.* N. B. Beyts, *Gujarat Agri.*, 1878, 44.]

D.E.P., iv., 413–5. Madras. Chief Districts. Forecast.

MADRAS.—Area and Production.—The area under cultivation in 1904–5 was 126,300 acres, and the outturn 16,700 cwt. The principal districts are ordinarily Cuddapah, which in 1904–5 had 32,149 acres; South Arcot, 28,784 ; Nellore, 14,618 ; North Arcot, 7,352 ; Karnul, 7,056 ; Anantapur, 5,098 ; and Kistna, 3,208. The forecast for 1905–6 shows an estimated area of 212,300 acres and an outturn of 1,896 tons. Commenting on this result, the Board of Revenue in their final report for 1906–7 show that this area is 86 per cent. more than in 1905–6, but 1 per cent. less than the average of the five previous years and 25 per cent. less than the ten previous years. Indigo appears to be cultivated under very diverse conditions throughout the Presidency. " Returns show that somewhere in the district sowing is normally being accomplished in every month of the year. This, no doubt, is due to the more even distribution of temperature and rainfall throughout the year " (Leake).

Seasons.

In Cuddapah, the chief indigo district, the land is ploughed and manured after it has been moistened by rain. This takes place in April if the rain is sufficiently heavy; if not, in July or August. The ground is then allowed to remain till the next heavy showers, when the seed is sown in rows. In about a month weeding commences. On dry lands the crop is entirely dependent on rainfall. The first cutting is taken three or four months after sowing, and a second and third at intervals of three months after the first. After the third cutting, the plant is allowed to seed.

Wet Cultivation.

Wet cultivation is also carried on in the neighbourhood of tanks or wells. Near wells with a certain supply of water, cultivation is commenced in March or April. If the soil is loose, the seed is sown without any previous ploughing; otherwise, in the vicinity of tanks, the land is watered, ploughed, and smoothed by a roller. It is then manured, watered again, and the seed sown when the land has dried. After germination, the crop is regularly watered at intervals varying from a week to twenty days. Weeding commences a month after sowing, and the first cutting takes place in three or four months, the second three months later. [*Cf.* Shortt, *Man. Ind. Agri.*, 1885, 98–136; *Mem. on Prog. Madras Pres.*, 1893, 69–71; Cox, *Man. North Arcot Dist.*, 1895, i., 273–4.]

D.E.P., iv., 415–6.
Burma.
Areas.

BURMA AND ASSAM.—Area and Production.—Indigo is cultivated to a very limited extent in Burma. In 1904–5 there were 424 acres in Upper and 58 in Lower Burma. In Upper Burma cultivation is confined to the districts of Pakokku, Lower and Upper Chindwin and Sagaing, and in Lower Burma to Thayetmyo. The gravest suspicion, however, should be entertained in accepting the published figures of area as being ***Indigofera.*** The description given by Mr. H. G. A. Leveson, in a note on the dyes of the Southern Shan States, at all events, leaves little or no doubt that much of the indigo of that country is derived from ***Strobilanthes.*** In Chindwin there are reported to be two crops, the wet- and the dry-weather. The wet-weather crop is sown in June and collected in July and August; the dry is sown in October and collected in December and January. An indigo plant is also said to flourish at high elevations in the Shan States. It is remarked that when cultivated in the lower valleys it is generally under the shade of trees, and when grown on the hills, plots of ground are selected at the bottom of steep valleys. Brackish soil is regarded as the most suitable, and the ground is not manured. It is not grown from seed, but at the beginning of the rains the shrub is cut to the ground, the lower part of the stalk thrown away, and the upper part with the young leaves planted. Two or three pluckings are considered a fair average yield, though a well-grown plant may afford as many as five. Most of these statements, it may be inferred, denote ***Strobilanthes.***

Seasons and Crops.

Different Species.

Assam.

Turning now to Assam, the cultivation of indigo may be said to be practically non-existent. The greater part of the indigo dye of the province is the produce of ***Strobilanthes flaccidifolius***, and not of ***Indigofera.*** In many respects Assam and Upper Burma show a closer approximation to the conditions of South and Central China than to those of India. Accordingly Assam, in the matter of this particular indigo-yielding plant, may be spoken of as the most western portion of the area of ***Strobilanthes flaccidifolius***, a plant that is from there diffused east and north throughout the greater part of China and becomes one of the most important sources of the dye in that vast empire. [*Cf.* Leveson, *Dyes and Dyeing in Southern Shan States*, 1896, 2–5; Duncan, *Dyes and Dyeing in Assam*, 1896, 28, 29; Parlett, *Rept. Settl. Oper. Sagaing Dist.*, 1903, 15.]

Manures.

Manures.—Generally speaking the only manure given in indigo cultivation is the refuse of the indigo plant termed *seet*, procured from the factory. Artificial manures have made little headway, and even with the simpler fertilisers, such as lime, gypsum and nitre, there is uncertainty as to their efficacy. In this connection attention should be given to the results obtained by Mr. C. Rawson, summarised in his final report to the Bihar Indigo Planters' Association, published in 1904. As a rule indigo soils were found deficient in available phosphoric acid, and responded remuneratively to treatment with superphosphate, bonemeal or other phosphatic manures. Nitrogenous manures were generally found useful when applied along with phosphates. Dr. Hancock, working at Dalsing Serai under Mr. Bernard Coventry in 1901 (*Rept. Indigo Improv. Syndicate*, 1901), arrived at the same conclusions. The value as manure of the refuse plant (*seet*) was also investigated by Rawson, with the result that he came to believe that in many cases it was as valuable as the indigo produced by the factory. Mr. W. Popplewell Bloxam next took up the inquiry into the subject of indigo improvement by scientific manuring. In his report to the Government of Bengal, 1905, on the work carried out by Leake and himself at Dalsing Serai (in 1903–4), he summarises his experiments and results. The chief feature of these may be characterised as the supply of various carbonaceous materials to indigo soils with the view of ascertaining their effect on the growth of the nodule bacteria. The period of Bloxam's experiments was, however, too short to allow of any very definite conclusions. [*Cf.* Voelcker, *Improv. Ind. Agri.*, 1893, 106, 112, 259, 260–1; *Rept. Cawnpore Exper. Farm*; Bergtheil, *Acc. Sc. Invest. on Indigo*, in *Rept. Dept. Land Rec. and Agri. Beng.*, 1905, vii.–ix.]

Seet.

Superphosphates.

Carbonaceous Materials.

Dangers to the Crop.—"Under favourable conditions the young plant will appear above the surface on the seventh to the tenth day, from which time onwards it is exposed to many vicissitudes. It is no uncommon occurrence to find the destruction of the crop to be caused by a shower of rain. It has already been explained that the young plant is dependent on what may be termed 'bottom' moisture for its early growth, and on the condition of the soil which makes this available. The 'compacting' of the surface soil leaves a loose, dry layer on the surface which acts to a certain degree as a check on evaporation. The effect of rain is to do away with this dry layer and to establish a complete capillary system to the absolute surface. The ultimate result is a rapid decrease in the moisture of the superficial soil, which may ultimately be reduced to below the limit at which life can be supported. Under these circumstances the crust must be broken even at the cost of destroying half the crop. This is usually effected by the use of a light rake, or, in the case of a very light crust, by brushwood drawn over the surface. A prolonged spell of hot west winds, such as are common during April–May, in spite of the precautions taken to conserve the moisture, reduces this to below the needful minimum, and in this way the greater part of the crop may be lost."

Dangers.

Effect of Moisture.

Surface Crust.

"As regards pests little can be said. The larvæ of numerous Lepidoptera feed on the indigo plant, but in only one case are the ravages sufficient to cause serious damage. Under favourable conditions the larvæ of ***Agrotis segetis*** appear shortly after the young plant has broken through the soil, and before what is known as the '7-leaf' stage is reached. Plants attacked will be entirely stripped of their leaves, and a second sowing may be necessary. In bad seasons this may also happen, and necessitate a third sowing. It seems probable that the ravages of this pest are only

Pests.

Grubs.

serious in those lands which have been sown in indigo for several years in succession, and that a reasonable system of rotation would reduce the injury to a negligible quantity."

Aphides.

"Of other insect pests which assume dangerous proportions, there is an *Aphis* and a ***Thrips***, but little or nothing is known of the life histories of either. They both attack the young plant, rendering it stunted, and the latter, by destroying the mesophyll of the cotyledons and first foliage leaves, may kill the entire plant" (Leake). [*Cf.* Lefroy, *Caterpillar Pests of Indigo in Bihar*, in *Agri. Journ. Ind.*, 1906, i., pt. iv., 338-50.]

Yield.

Plants to the Acre.

Dye to the Acre.

Outturn and Yield.—"Owing to the numerous variations in the exact area denoted by the term *bigha*, and to the confusion consequent thereon, it is almost, if not quite, impossible to determine with any degree of certainty from the published returns what is a normal yield of plant and dye. Under these circumstances it seems best to give the returns for a particular concern for which the figures are available and which, being situated in the centre of the indigo districts of Bihar, may fairly be taken as normal. The period from which the averages are derived covers a term of eleven years, viz. from 1892-1903. This shows an average of 80 maunds of plants per acre for the *morhun* cutting, and 35 maunds of plants per acre for the *khunti* cutting, while the dye manifests an average of 16 lb. per acre for the year, in the proportion of 11 lb. for the *morhun* and 5 lb. for the *khunti* cutting. The fluctuations are, however, very wide, *e.g.* for plant per acre 168 to 48 maunds, and for dye, 25 lb. to 7½ lb" (Leake).

MANUFACTURE.

Manufacture: Wet Process.

Site of Factory Water Supply.

Steeping Vats.

WET PROCESS.—"For the manufacture of dye from the plant, the wet process is now almost invariably adopted. Briefly this consists in the extraction from the plant of the dye-yielding principle by steeping in water, and the precipitation, from the extract so obtained, of indigo by exposure to air—oxidation. As the amount of plant which must be daily steeped comes to some hundreds of cartloads, there are certain essentials which must be considered in choosing a site for a factory. Chief among these is an abundant supply of water; and a factory will never, therefore, be found at a distance from a stream or large lake, from which water can be pumped into a large tank—*khazanah*—placed at the highest point of the factory. From this tank channels conduct water to the steeping vats, a row of brick and cement-lined basins, usually about 20 feet square and 4 to 5 feet deep, and about 15 in number. Below these, and corresponding with them in number, are a second row of slightly shallower vats called the beating vats.

"The plant, on arrival at the factory, is loaded into the steeping vats and, as soon as each vat is full, is battened down by means of beams attached to pegs set in the sides of the vat. Water is now run in until the plant is just submerged, and steeping is allowed to proceed for a period varying from 12 to 14 hours. The liquor, which has by this time become yellowish green and almost fluorescent, is now run off into the lower, or beating vat.

Beating Vats.

"Beating is effected in various ways, the sole object being to obtain as thorough an oxidation as possible. In the more primitive method 10 to 12 coolies enter the vat and proceed to beat the liquor with short sticks to one end of which flat discs of wood are attached. The process is complete after about 1½ hours' continuous beating. With the introduction of machinery the hand beating has been to a certain extent replaced by wheel beating. Where this is employed, there is a single beating vat which runs the length of the range of vats and is divided along its length by one or two walls, the number depending on whether one or two beating wheels are employed. These walls stop short of the two ends of the vat and are simply employed to give direction to the circulation set up by the wheels. The wheels themselves consist of small flat discs of wood attached to the ends of a number of spokes radiating from the axle. By this method beating is complete in about one hour. More recently the beating has been replaced by blowing a mixture of air and steam through the liquor; and, later still, in 1902, this process, modified so as to blow ammonia through the liquor, was introduced by Rawson. Neither of these latter processes have, however, been universally adopted, and the wheel beating is still most commonly employed.

Machinery.

Blowing.

Ammonia.

"After beating is complete, the liquor is allowed to stand until the precipitated indigo—the *mal*—has settled, leaving a clear, red, supernatant liquor. This '*maila pani*' is drained off and the residual '*mal*' is pumped into boilers where it is mixed with clean water and boiled, either by the direct action of heat or by injecting steam. The boiling and subsequent stages in the manufacture take place within the factory building. When the boiling is complete, the contents of the boilers are run on to the '*table*.' This consists of a heavy canvas sheet which has been previously wetted and spread on a support of split bamboo. The cloth acts as a filter, allowing the clear water to drain off and retaining the indigo as a thick paste which is now transferred to the press. This is a square wooden box, the walls and bottom of which are perforated by numerous holes. The interior is lined with damp cloth and the *mál* is then poured in to a depth of 8 or 9 inches. The lid, which fits the interior accurately, is then put on and screwed home by means of a screw worked by a long lever. This is turned at intervals during 5 to 6 hours, in which time the *mál* will be pressed into a hard cake 3 to 3½ inches thick. The sides of the press are now removed and the cake is transferred to a table where it is cut by wire into cubes of about 3 inches. These are removed and placed on open shelves to dry in an airy room. The air admission is so regulated that slow drying is effected. This is essential if cracking and subsequent breakage of the cakes are to be avoided. During the process of drying, the cake becomes covered with a dense growth of mould. Before packing this is brushed off by coolies. The final stage consists in packing the dried and cleaned cakes into specially constructed cases which are weighed and forwarded to Calcutta for disposal" (Leake).

Mal.

Boiling.

Filtering.

Pressing.

Cutting into Cakes.

Drying.

Packing.

Dry Process.

DRY PROCESS.—The wet method just described by Leake is that which is almost universally employed, though in Madras the dry-leaf process is still pursued to a limited extent. From the historic chapter given above it will be seen, moreover, that during the first century of the industry as fostered by the East India Company, the dry process was apparently universally adopted. It was even upheld that to that fact was attributable the high merit of the Indian as compared with other indigoes—the stems and twigs used in the wet vat system detracted, so it was then believed, very greatly from the merit of the dye. During the second century, when the industry had been conveyed from the West Indies back to India, or rather to Bengal, the wet process was alone that employed. It is significant that throughout all this rise and fall of the

Early Followed.

Native Methods.
Dry Leaf.
Steeping.
Adulteration.
Advantages.

European industry in India, the Natives should have quietly continued their own methods of manufacture, oblivious of or indifferent to the numerous patent processes and appliances brought out by their European rivals. By the dry method the bundles of freshly cut plant, instead of being conveyed directly to the factory, are dried and the leaves separated from the stem by beating. When kept dry the leaves turn in the course of a few weeks from green to a blue-grey colour. They are then subjected to steeping and fermentation, when the *indican* present in the plant splits through hydrolysis into *indigotin* and *indiglucin*. The fine green liquor thus obtained is then drawn off to the beating vat, where the matured indigo is precipitated and subsequently concentrated by boiling and compressed into cakes and dried in the usual way. But for the adulteration so largely resorted to by the Native manufacturers, it seems fairly certain the dry-system indigo would be fully as valuable as the wet, and in some respects have distinct advantages. This is exemplified by the fact that it is preferred even in localities where the difficulty of drying becomes serious. For a small manufacturer it has the great advantage of being attended to at the most convenient time.

Chemical Changes.

The rationale of indigo manufacture may be briefly and pointedly told. Fermentation and hydrolysis of the *indican* found in the steeping vat takes place. The *indigotin* produced is reduced by the *indiglucin* to *hydrindigotin* (indigo white), and this dissolves in the alkaline liquor. Through the beating that follows the *hydrindigotin* is reoxidised, and *indigotin* precipitated—being insoluble in the alkaline liquid. The yield is about 0·2 per cent. of the weight of the plant. The addition of ammonia to the vat is frequently practised, with the result that the yield is largely increased, as the formation of ammonia by the fermentative breaking down of the indigo is thus hindered. The indigo obtained in this manner varies greatly in quality. Its content of *indigotin* ranges from 20 to 90 per cent., the average being 40 to 50 per cent. The remainder consists of ash, 5 to 20 per cent.; water, 2 to 8 per cent.; indirubin, 2 to 4 per cent., and various amounts of indigo-brown, indigo-gluten, and carbohydrates. The value of the blue depends on its content of *indigotin* and *indirubin*. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 320.] It is believed the presence of *indirubin* gives the more pleasing result of the natural as compared with the synthetic dye.

Analysis of Indigo.

Mr. W. Popplewell Bloxam (who has devoted much attention to the study of the chemistry of indigo) read a highly instructive and valuable paper before the Society of Chemical Industry (Yorkshire Section) on August 15, 1906, and still more recently a further paper before the London Section on November 30, 1907. The last mentioned is written by Bloxam in collaboration with Dr. R. Gaunt and Mr. F. Thomas, and is specially described as an analysis of indigo and of the dried leaves of ***I. arrecta*** and ***I. sumatrana***. It is, therefore, desirable that readers anxious for information of the nature indicated should consult the papers mentioned. But it may be useful to give here the few concluding remarks in the first, since these seem to give an indication of the direction and purport of Bloxam's investigations :—

Purport.

"From these results, it will be seen that if the percentage of indigotin contained in the whole plant (ordinary Indian varieties) be taken, as seems reasonable, at 0·6 per cent., then from consideration of the weights of plant steeped and the indigotin recovered in the finished cake, the highest efficiency attained does not reach 50 per cent. of the total indigotin obtainable, whilst the average efficiency of the '*mahai*' is 25 per cent., falling thence to 12·6 per cent. (cake No. 2). The attention of the Government of India will be called to this wasteful method of manufacture, with a view to the long-needed improvements being introduced to India without delay." Concluding the second paper, Bloxam and his collaborators observe :—" Being now in the possession of some 150 grms. of crystallised indican, we are undertaking a scientific study of its quantitative conversion, by various methods, into indigotin—with the view of improving the process of manufacture at present in use in India. The results of our experiments all tend to show that considerable improvement remains to be made in the efficiency of the indigo manufacture, and point to the fact that the efficiency of the process is far lower than is currently stated." Bloxam submitted his final *Report of the Research Work on Indigo* to the Government of India in 1908.

Improvement of Manufacture.

[*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 1833, 307–14; Montgomery Martin, *Hist. E. India*, 1838, ii., 986–96; Reid, *Cult. and Manuf. of Indigo*, 1887, 65–73, 74–86; Nicholls, *Trop. Agri.*, 1892, 256–9; Bridges Lee, *Man. of Indigo*, 1892; *Journ. Soc. Chem. Indust.*, April 30, 1894, xiii., 382; Oct. 31, 941; Feb. 28, 1901, xx., 116–7; March 31, 466–7; Sept. 30, 886; May 15, 1902, xxi., 607; *Rept. on Coventry's Indigo*, 1895, 1897, 1898; Cave, *Rept. on Patent Silicate Process of Indigo Manuf.*, 1901; Rawson, Gardner and Laycock, *Dict. Dyes, Mordants, etc.*, 1901, 174–80; Perkin, *Condition of Indigo Indust.*, *Nature*, Nov. 1, 1900, lxiii., 7–9; Nov. 29, 111–2; Jan. 24, 1901; Brèaudat, *Contrib. à L'Etude de la Fabricat. de l'Indigo*, in *Bull. Econ. L'Indo-Chine*, July 1903, n.s., vi.]

Synthetic Indigo.

SYNTHETIC INDIGO.—It would be impossible to deal here with the discovery and production of synthetic indigo. As a matter of historic interest it may be mentioned that Perkin was (in 1856) the original discoverer of the coal-tar dyes, but, like Green's discoveries still later, they were not fully appreciated until they had reached the Netherlands and German laboratories. Hence for a good many years past the artificial dyes have proved formidable rivals to the natural colours, and even in the case of indigo have begun to curtail the world's demand for the Indian article. Already the exports from India have been reduced very seriously. Germany, for example, has practically ceased to import vegetable indigo, and her exports of the artificial products to all countries were last year valued at 25,000,000 marks (£1,250,020). This is remarkable, seeing that the first commercial manufacture was only made in 1897. According to a report issued by the Badische Anilin and Soda-Fabrik Company, their profits were in 1903, £583,787, and in 1904, £544,936. Thus it would appear probable that large sums have been realised from the sale of artificial indigo. The imports of synthetic indigo are mainly from the Netherlands. These came to 14,691 cwt., valued at £143,613 in 1902; 17,752 cwt. in 1903; 19,458 cwt. in 1904; 32,246 cwt. in 1905; and 39,042 cwt., valued at £147,325 in 1906.

Great Britain's Supply.

D.E.P., vi., 461-9.
Trade.

TRADE IN INDIGO.—In a dispatch dated 1792, the Board of Directors congratulated the Indian Government that, as the British imports of Bengal indigo increased, those from the Spanish and French colonies declined, while at the same time a large export trade from Great Britain to the Continent had been established. That re-export trade amounted in 1790 to close on one million pounds of the dye. Such a brilliant result, when contrasted with the depression that has been cast over the industry, within the past few years, is highly significant. But

Early Transactions.

with the detailed statement of former transactions, given in the *Dictionary*, it may suffice to review here, and very briefly, the returns of the past few years :—

Exports.

Record Year.

Decline.

Exports.—The bulk of the factory-made indigo is exported. India uses up only the most inferior grades of the dye. The returns of foreign trade thus very nearly express the total production. The year 1894–5 showed the highest production credited to the Indian industry, viz. 237,494 cwt., produced from 1,688,042 acres. Up to that point the prosperity was almost phenomenal—a century of advancement, in spite of numerous local upheavals. But the year following the first commercial production of synthetic indigo the crash came, and from that time there has been nothing but continuous curtailments. From 1894–5 down to 1906–7 the record is, in fact, a very melancholy one. The exports in 1894-5 were 166,308 cwt., valued at Rs. 4,74,59,153, and in 1895–6 they were 187,337 cwt., valued at Rs. 5,35,45,112. But the twelve years following show a continuous decline, until in 1906–7 the exports were only 35,102 cwt., valued at Rs. 70,04,773. Commenting on this subject, J. A. Robertson (*Rev. Trade Ind.*, 1904–5, 28–9), at that time Director-General of Statistics in India, wrote : "The unremunerative level to which prices have been forced down by competition of synthetic indigo has reduced the indigo plantations of Bengal to less than half the area they occupied ten years ago, and over the whole of India the reduction in that period was 66 per cent. Planters in Bengal are strengthening their position by cultivating other crops in addition to indigo, and they can carry on a contest for supremacy with synthetic indigo for many years." "The season of 1904 gave a very poor yield, the deficiency compared with the previous year being estimated in the official reports at 31 per cent. in Bengal and 45 per cent. for the whole crop. The total exports of 1904–5 are less by 18·4 per cent. in quantity, and 22·4 per cent. in value, than the exports of the previous year. The fall in the average price was thus 4 per cent., and in Calcutta the fall was more marked in the better kinds than in the ordinary qualities."

Great Brita
Share.

United States.

Egypt.

Turning now to the countries which have drawn on India for their supplies of indigo, Great Britain formerly headed the list. The exports from India to Great Britain in 1875–6 came to 72,494 cwt. ; in 1883–6 to 64,204 cwt. ; in 1895–6 to 66,215 cwt. ; and in 1898–9 (the year after the production of synthetic indigo) they dropped to 30,973 cwt. ; since which date they have steadily declined until in 1904-5 they were only 10,743 cwt. ; in 1905–6, 7,749 cwt. ; and in 1906–7, 7,942 cwt. The record of the United States is somewhat similar, though on a smaller scale. In 1875–6 the share taken by the States came to 4,089 cwt. ; ten years later it became 20,737 cwt., and from then a decline has been observed until in 1905–6 the amount taken was only 1,530 cwt., and in 1906–7, 1,258 cwt. Egypt, on the other hand, has preserved a fairly constant market, but it has to be explained that Egypt takes mainly Madras dry-leaf indigo. In 1875–6 it drew 577 cwt. ; in 1885–6, 11,601 cwt. ; in 1895–6, 13,995 cwt. ; in 1903–4, 15,375 cwt. ; in 1905–6, 9,702 cwt. ; and in 1906–7, 9,195 cwt. With most Continental countries the decline in the demand for Indian indigo has been most marked. Germany took in 1895–6, 16,929 cwt. ; in 1903–4, only 1,776 cwt. ; in 1905–6, 487 cwt. ; and in 1906–7, 523 cwt. France procured in 1895–6, 21,011 cwt. ; in 1903–4, 1,975 cwt. ; in 1905–6, 970 cwt. ; and in 1906–7, 541 cwt. Japan, which for several years had been one of the chief markets, almost ceased to import in 1904–5. This, it is believed, was largely a consequence of "the differential taxation which took effect from April 1, 1903 and imposed an extra tax, equal to 1·55 pence per lb., on Indian indigo, which both Java plant indigo and German synthetic indigo escaped, placing an insupportable burden on the trade; but now that Indian indigo has been treated on the most-favoured-nation basis by the Convention with Japan, which came into force on March 15, 1905, there may be some revival of the trade. German synthetic indigo has, however, now acquired such a dominant position, and its higher percentage of colouring matter still retains for it such advantage by reason of the duty being charged by weight, that India will find it difficult to recover lost ground" (Robertson, *l.c.* 29). The exports from India to Japan in 1906–7 were 1,800 cwt. [*Cf. Rept. Beng. Chamber of Comm.*, 1903–4, 163–8.]

Internal Trade.

Internal Trade.—Turning now to the shares taken by the provinces of India. In 1885–6 the total exports were 132,495 cwt., of which the Bengal share was 76,109 and the Madras 45,828. Ten years later (1895–6) the total exports were 187,337, of which the Bengal share was 111,714 and the Madras 62,425 cwt.; in 1903–4, 60,410, of which Bengal furnished 29,858 and Madras 24,414 cwt.; in 1905–6, 31,186, of which Bengal supplied 19,062 and Madras 7,756 cwt.; and in 1906–7, 35,102, of which Bengal contributed 19,309 and Madras 11,159 cwt. The exports across the land frontier are not very important. In 1904–5 they came to 4,873 cwt., valued at Rs. 4,70,203; in 1905–6 to 5,275 cwt., valued at Rs. 5,26,431; and in 1906–7 to 3,518 cwt., valued at Rs. 3,47,341. The most important receiving countries are Seistan and Dir, Swat and Bajaur. Formerly a large trade was done in exporting indigo-dyed goods from India. The only survival of this is the export of blue cloth from Pondicherry to French China—a survival due, apparently, to the French protectionist enactments in favour of her colonies.

French Protectionist Enactments.

Imports.

Imports.—A startling peculiarity of the present phase of the Indian traffic in indigo may be said to exist in the circumstance that a small supply of the dye is annually drawn from the Straits, from the United Kingdom, Belgium and Japan. There is no mention of synthentic indigo being imported, and the small foreign supply may be to some extent returns of Indian indigo. The imports in 1905–6 were 1,244 cwt., valued at Rs. 1,12,243; and in 1906–7, 2,392 cwt. and Rs. 97,152.

D.E.P., iv., 470–1. Insects.

INSECTS (INSECTA); *Fa. Br. Ind.;* Hampson (Moths), i.–iv., Bingham, *Wasps and Bees* (Hymenoptera), i.–ii.; Distant, *Bugs* (Rhynchota), i.; Watt, *Products Derived from Animal Kingdom* (Insects), 64–5; Maxwell-Lefroy, *Economic Entomology*, in *Journ. Bomb. Nat. Hist. Soc.*, xv., 432–44; also *Locusts in India*, in *Agri. Journ. Ind.*, 1907, ii., pt. iii., 238–45, tt. xiv–xx.

Economic Value.

With the exception of the silkworms, the bees, the cochineal, the lac and the gall-forming insects, very few others can be regarded as of economic value. Unfortunately a very large number of insects force attention through the depredations they effect on crops, stores of food, industrial materials, manufactures, woodwork, etc. Maxwell-Lefroy has set forth in a lucid manner the difficulties that beset the entomologist in India who may have entrusted to him the investigation and solution of the pests of the fields and forests or the discovery of beneficial insects. The insects have to be identified and in many cases scientifically named, then their life-histories worked out, before practical suggestions are possible. Throughout the present publication the effort has been made to record the results

Pests.

hitherto attained under the names of the products concerned, such as ***Corchorus*** (Jute), ***Camellia*** (Tea), etc. But in addition, the following special articles deal with insect economic products :—

Bees', Bees'-wax, Dammar and Honey (see pp. 123–9).
Coccus Cacti, Cochineal (pp. 347–9).
Silk (pp. 992–1013).
Tachardia Lacca (pp. 1053–6).

Besides these, however, there are a few other insects that have attracted attention. Perhaps the most important is the LOCUST. This often proves so destructive that strenuous efforts become necessary to restrain it. In order to aid in their identification, Maxwell-Lefroy has recently published an interesting account of the life-histories, with full-page illustrations, of the two locusts known to India, viz. the Bombay Locust and the North-West Locust. [The following papers have appeared in *The Agricultural Ledger* :—Gunther and Cotes, *Dried Locusts as food for Cage and Game Birds*, 1893, No. 2 ; *The Automatic Locust Catcher*, 1895, No. 15 ; Stewart Stockman, *A Plague of Grasshoppers in the C. Prov.*, 1903, No. 3, 56–85 ; Maxwell-Lefroy, *Mem. Dept. Agri. Ind.*, 1906, i., No. 1 ; 1907, i., 125.] Sly (*Agri. Journ. Ind.*, ii., pt. ii., 208) gives a brief forecast of a report shortly to appear on the results attained in India with the locust parasitic fungus.

The wing-cases of the beetle ***Buprestis vittata*** are largely employed for ornamental purposes in India, and are especially worked up in articles of dress produced in Madras and Hyderabad, or are used in *khas-khas* fans, etc. [*Cf. Mukharji*, *Art Manuf. Ind.*, 309, 313, 380 ; Watt, *Ind. Art at Delhi*, 1903, 161, 198, 408.]

D.E.P., iv., 476–96. **IPOMŒA**, ***Linn.*** ; *Fl. Br. Ind.*, iv., 196–215 ; Prain, *Beng. Plants*, 1903, ii., 731–7 ; Cooke, *Fl. Pres. Bomb.*, 1905, ii., 241–52 ; CONVOLVULACEÆ. A genus of herbs, rarely shrubs, twining, prostrate, or less often sub-erect.

Wild Pot-herb. **I. aquatica,** *Forsk.* ; *Rec. Bot. Surv. Ind.*, ii., 121, 185, 243 ; iii., 81. The *kalmi-sák*, *nári*, *ganthian*, *nálichi baji*, *sarkarei valli*, etc. An aquatic species common throughout India but especially abundant on the surface of tanks in Bengal. The young shoots, leaves and roots are universally eaten as a vegetable, and the plant is for that purpose often semi-cultivated. The juice is believed to have emetic properties and to be useful in opium poisoning. [*Cf. Pharmacog. Ind.*, ii., 540 ; Dutt, *Mat. Med. Hind.*, 1900, 302.]

I. digitata, *Linn.* ; Talbot, *List Trees, etc.*, 1902, 251. The *bilái kand*, *bhui-kohala*, *matta-pal-tiga*, etc. A large climbing perennial cultivated on account of its pink to purple flowers and its tuberous roots, used in Native medicine (see p. 1120). [*Cf. The Bower Manuscript* (Hoernle, transl.), 1893–7, 96 ; *Pharmacog. Ind.*, ii., 534–6 ; Dutt, *l.c.* 323.]

• **I. hederacea,** *Jacq.* ; *Rec. Bot. Surv. Ind.*, iii., 244. The *nil-kalmi*, *baunra*, *bíldí*, *kodi*, *kálá-dáná*, *kákkatán-virai*, etc. An annual hairy twiner, cultivated in India, but also found wild. The seeds known as *kálá-dána* and *mirchai* are purgative and resemble jalap in their action. They were made officinal in the Pharmacopœia India in 1868. The market rate is about 4 annas per lb. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 32–3) says that the seeds contain 8·05 per cent. of resin resembling *convolvuline*, but in addition are rich in albuminous substances and contain 14·02 per cent. of a nauseous fat—a disadvantage in internal administration. [*Cf. Pharmacog. Ind.*, ii., 530–4 ; Henry, *Econ. Bot. China*, 1893, 49 ; Firminger, *Man Gard. Ind.* (ed. Cameron), 1904, 476.]

Jalap. **I. Purga,** *Hayne.* Jalap. A climber, native of the Mexican Andes, at altitudes from 5,000 to 8,000 feet above the sea. In its native habitat rain falls almost daily, and it flourishes best in shady woods with a deep rich humus soil.

In India it is cultivated on Dodabetta in the Nilgiri hills, and in the North-Western Himalaya at Mussourie. The crop is an exhausting one. Formerly the plant was grown among the cinchona trees, but this system has been abandoned, since while the jalap flourished the cinchona was injured. Plants may be obtained from cuttings set under shade in a moist, sandy soil, but for cultivation on a large scale the smaller tuberous roots may preferably be used. These are placed one foot apart and at a depth of about six inches within trenches filled with farmyard manure. As the plants grow, stakes require to be fixed for them to climb on. A return may be expected in the third year, and every third year thereafter. In Ootacamund it has been found that an acre of jalap yields 5,000 lb. of green tubers, or say 1,000 lb. of powder. The drying process is a difficult one, as there is frequently considerable loss through mouldiness and fermentation. It is said this may be prevented by cutting the tubercles in slices.

Medicinally, jalap is well known as a hydragogue purgative, its action being due to certain resinous principles. The selling price has been given at about *2s. 3d.* per oz. [*Cf.* Nicholls, *Textbook Trop. Agri.*, 1892, 237–40; Hooper, *Effect of Phosphatic Man. on Growth of Jalap* (Reprint from *Pharm. Journ.*), 1896; *Kew Bull.*, 1897, 302; *Brit. Pharmacop.*, 1898, 165; Thorpe, *Dict. Appl. Chem.*, 1900, iii., 349; *Pharm. Soc. Mus. Rept.*, 1895–1902, 62–3; *Pharm. Journ.*, 1904, lxxii., 284–5.]

I. Turpethum (see **Operculina Turpethum**, p. 822).

Sweet Potato.

I. Batatas, *Lamk.;* Duthie and Fuller, *Field and Garden Crops*, 1893, iii., 12, tt. 87–8; *Rec. Bot. Surv. Ind.*, ii., 41, 120, 185; iii., 80, 245. Sweet Potato, *míta-álú*, *ranga-álú*, *chine álú*, *shakarkand*, *vallikilángu*, etc.

Habitat.—Presumably a native of America, but is extensively cultivated in India. Two forms are met with, one with red, the other with white tubers. Evidence points to its having apparently reached the Pacific Islands in prehistoric times, and to a cultivation in China in the second or third century of our era. Asa Gray (*Scient. Papers*, 1889, i., 317–20), reviewing the account given in De Candolle's *Origin of Cultivated Plants*, gives full particulars of the literary evidence in favour of an American origin. The first mention of the plant appears to be by Peter Martyr, who in the 9th book of his *2nd Decade* (written about 1514), gives *Batatæ* among the fruits of the province of Uraba, Darien, and in his *3rd Decade* names them among the plants growing in Honduras when Columbus landed in 1502. Other early Spanish travellers, *e.g.* Cieca de Leon, Jean de Lery, etc., also refer to the finding of sweet potatoes in Peru and Brazil. Clusius, moreover (*Rar. Stirp. Hist.*, 1576, ii., 297–9), states pointedly that they grow wild in the New World and adjoining islands, whence brought to Spain. Nothing very definite can be learned of its introduction into India. The plant is figured and described by Rheede (*Hort. Mal.*, 1688, vii., 95, t. 50) and by Rumphius (*Herb. Amb.*, 1750, v., 370, t. 130). Carey (*As. Res.*, 1808, x., 18) discusses the method of cultivation pursued in Dinajpur, and Roxburgh (*Fl. Ind.*, i., 483) speaks of the red sort as cultivated all over the warmer parts of Asia.

Cultivation.

Cultivation.—The area under the sweet potato in India cannot be definitely ascertained. It is grown all over the country from the Panjáb, the United Provinces, Rajputana, Central India, the Central Provinces, Bengal, Assam, Bombay, Madras and Burma. In Bengal it is more important in the eastern tracts, such as Bogra and Bhagalpur, than in the western and central divisions. Taking India as a whole, it is planted from August to November and reaped from December to May, the variations being a consequence of local climatic conditions and methods of propagation. A full account of its production in Bombay is given by Mollison (*Textbook Ind. Agri.*, 1901, iii., 193–7), of which the following summary may be accepted as true of India generally. The best soil is a light friable one, well prepared by deep tillage. The crop does not thrive unless the land be naturally dry. It is generally grown during the cold season and under irrigation, but on light, dry land a rain crop may be produced. The land is prepared during the monsoon by frequent ploughings, and in September farmyard manure at the rate of thirty cart-loads per acre is given. Before planting, irrigation beds are formed of various sizes according to local circumstances.

Seasons.

Propagation.

Planting usually takes place in October–November. The crop is propagated by cuttings from fairly mature portions of the stem, each with three nodes or leaf-buds. Two nodes are placed underground, 2 to 3 inches deep, while the other node is left free. The cuttings are usually placed along ridges, though sometimes in flat beds. The ridges are about 18 inches apart and the cuttings are deposited one foot apart on each side of the ridge, half-way between the crest and the bottom of the furrow. Cross furrows are also drawn which form channels for irrigation. Weeding should be attended to and the crop watered every eight or twelve days. Care must also be taken to prevent the plants rooting at the nodes, for otherwise small tubers of no value will be formed at the points of attachment and these will deduct from the growth of the large tubers at the main root.

Yield.

Yield.—If planted in October–November the crop should be ripe in April and the tubers lifted at once, else much damage will be done by rats and white ants. The vines or *haubus* are reaped before the tubers are dug. A good crop may yield six tons per acre, worth about Rs. 300. The cost of cultivation in the Surat district Mollison gives as Rs. 134.

Alcohol.

Sugar and Alcohol.—The sweet potato contains more dry starchy and sugary matter than the ordinary potato, but less nitrogenous substance. Analysis shows it to possess about 10 to 20 per cent. of sugar and about 16·05 per cent. of starch. It is said to be an excellent source of alcohol, 100 kilos of tubers yielding about 12 to 13 litres of absolute alcohol.

Recently it has been largely cultivated in some parts of the world as a source of sugar. By the Natives of India it is commonly used as food, either cooked in curry or boiled, roasted or fried.

[*Cf.* Piso, *De Med. Brazil*, 1648, 94 ; Hernandez, *Nova Pl. Hist.*, 1651, 299 ; Forster, *Pl. Esc.*, 1786, 55–6 ; Bentham, *Rev. of Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 141–2 ; De Candolle, *Orig. Cult. Plants*, 1884, 57–8 ; Basu, *Agri. Lohardaga*, 1890, pt. i., 78 ; Nicholls, *l.c.* 288–90 ; Duggar, *Sweet Potato Cult., etc., U.S. Dept. Agri. Bull.*, 1895, No. 26 ; Thorpe, *Dict. Appl. Chem.*, 1898, i., 292 ; Woodrow, *Gard. in Ind.*, 1899, 391 ; *Der Tropenpflanzer*, 1902, vi., 285–96 ; Mollison, *Amer. Sweet Potatos for Ind.*, in *Ind. Planting and Gard.*, Oct. 30, 1902 ; *Sweet Potato Sugar in Formosa*, Aug. 1, 1903 ; *West Ind. Bull.*, 1901, ii., No. 4, 293–302 ; 1902, iii., No. 3, 206–11 ; v., No. 1, 5–6, 25–6, No. 3, 281–6 ; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 478.]

D.E.P., iv., 499–524. Iron.

IRON AND IRON MANUFACTURES.—Ball, *Man. Econ. Geol. Ind.*, iii., 335–420 ; Watt, *Rev. Min. Prod. Ind.*, 1894–7 ; Mahon, *Rept. Manuf. of Iron and Steel in India*, 1899 ; Holland, *Rev. Min. Prod. Ind.*, 1898–1903, 11–2, 51–2.

Ores.

PRODUCTION.—Iron is commonly said to exist in nature in two great classes of workable ORE—(1) Carbonates and clay ironstone, and (2) Oxides, like hematite and magnetite. The CARBONATES consist essentially of two kinds : (*a*) those in which the salt is crystalline and little admixed with earthy matter, and (*b*) those in which a larger or smaller amount of clay is intimately intermixed with the ferrous carbonate. The former is *spathic* iron ore and the latter *argillaceous* ore or clay ironstone. Clay ironstone exists in large deposits in many coal measures and is then known as black-band. The OXIDES may be spoken of as of three kinds (*a*) anhydrous ferric oxide ; (*b*) hydrated ferric oxide ; and (*c*) a mixture of ferrous and ferric oxides such as the magnetic oxide of iron. Hughes Buller has recently sent from Baluchistan a natural mineral known as *khaghal* or *lagh*, which is employed as a dye. This has been ascertained to be an impure sulphate of iron. " The most abundant iron ores are the minerals magnetite and hematite which occur in numerous places with quartz, making quartz iron-ore schists which are generally members of the Dharwar and other Archæan schist series. The most conspicuous examples of this class occur in the Salem district and the Sandur State in the Bellary district of the Madras Presidency, and in the Chanda, Raipur, and Jubbulpore Districts of the Central Provinces. The chief ore now used at the Barakar iron-works for the manufacture of pig-iron is clay ironstone, containing 45 to 48 per cent. of iron, and occurring as nodules in shaly formation separating the Barákar and Ráníganj stages of the Dámuda series in Bengal" (*Imp. Gaz.*, 1907, iii., 145–6).

Most Abundant.

Notwithstanding the fact that rich deposits of one or other of these various iron ores exist here and there all over India, and have, from the most ancient times, been worked up in a desultory manner by the Natives, still there has been but one successful attempt on European lines and by modern appliances. Indeed some of the recent investigations conducted in India would seem to establish belief that few of the important supplies of ore are of sufficiently high merit to defray the cost of carriage to Europe (or even to Indian centres of fuel supply) and leave a margin of profit. The opinion would thus appear to have been borne home that the expansion of India's iron production must, for the present, be looked for in the immediate vicinity of fuel supplies.

Successful Attempt.

Proximity to Fuel.

South India.

South India.—Some few years ago many persons urged that if it paid to convey Spanish ore to England to be there made into "pig" which in the ordinary course of trade was profitably carried even to India, it must of necessity pay to convey the rich ores of Madras to the coal mines of India to be there worked up in competition with the imported foreign metal (Watt, *Mem. Res. Ind.*, 1894). It was also even upheld that the time might soon arrive when England would have to look to Salem for its supplies of magnetic ore. In his presidential address to the Iron and Steel Institute (of May 1893), for example, Mr. W. Richards suggested that Indian ores could and should be substituted for Spanish. And still further it was loudly proclaimed that with some co-operative organisation of the Forest Department, South India might easily supply charcoal in such abundance and at such a price as to admit of production of iron after the fashion pursued in Styria and certain districts of America. These and other such opinions led to various technical investigations and reports on the part of experts employed both by private individuals and by Government. The Secretary of State for India, for example, submitted the then available information to Mr. Jeremiah Head, formerly President of the Institution of Mechanical Engineers, for favour of his views, the result being a most valuable contribution dated May 2, 1896. This is concluded as follows:—"I regret to have to say that in my opinion it is not at present practicable to conduct an iron industry at or near Salem upon the methods pursued in Styria and certain districts of America where charcoal is employed." It was perhaps but natural that with a subject which had not passed from the stage of personal opinion to that of ascertained results, some at least of Head's statements would be challenged. His final conclusion, in fact, has by no means been universally accepted in India, and the accuracy of the information on which he based his calculations of cost of production of iron, as also the supply of crude ore for direct export to Europe, has been called into question. The Board of Revenue, Madras, for example, observed that "If it can be shown that Mr. Head's estimate can be safely reduced to Rs. 50 per ton f.o.b., as the Board believes that it can be, and freight can be obtained at 15*s.* per ton, the estimate taken by

Magnetic Ore.

Charcoal.

Jeremiah Head's Report.

Data called into Question Board of Revenue.

Mr. Head (at page 18 of his report), it will be possible to deliver Kanjamalai pig-iron in England for £3 15*s.* 10*d.* per ton, being 5*s.* 2*d.* below the minimum value of imported Swedish pig, £1 4*s.* 11*d.* below the maximum, and 12*s.* 3*d.* below the average. The same iron could also compete still more favourably with Swedish pig imported into Madras, Calcutta and Ceylon."

Test Consignment.

In 1898 a consignment of Kanjamalai Salem ore was sent to England to be tested along with Indian coke supplied for that purpose. The experiment was conducted by Messrs. Bolckow, Vaughan & Co. at Middlesborough, with the result that it was found to contain only 40 per cent. magnetic iron—in fact, that it was not worth exporting. This led to an acrimonious correspondence in the public press, in which it was affirmed that the sample sent was not selected ore but an average of the whole rock, and thus contained much that ordinarily would never be conveyed from the mine to the smelting furnace. It was urged that the results of previous investigations (such as those conducted by Dunstan, *Imp. Inst. Tech. Repts.*, 12–22) showed a much higher average merit. Six samples examined gave 56·95 average, with the highest 70·06 and the lowest 36·44 per cent. of iron.

Major Mah
Opinion.

The Porto Novo Iron Company, founded by Mr. Josiah Marshal Heath, was the earliest and perhaps the most persistently worked concern in India. It was founded in 1830, changed hands more than once, and was finally dissolved and its privileges surrendered to Government in 1874. For thirty years a large quantity of iron was manufactured, and failure, as Major R. H. Mahon says, was not due to lack of iron ore or its quality, but to inexperience, defective machinery, and want of capital. He is, moreover, strongly of opinion that all existing difficulties will be overcome and iron production from the South Indian supplies made an industry of the greatest possible value. Persons interested in this subject should therefore procure Mahon's admirable report. It would thus seem that the whole subject needs to be even still further investigated before it can be regarded as satisfactorily disposed of one way or the other.

C. Prov.

Central Provinces and Orissa.—Hardly less satisfactory are the results of the inquiry made regarding the iron supplies of the Central Provinces. The report of investigations conducted by Mr. E. P. Martin and Prof. Henry Louis (on behalf of the Right Hon. Sir E. Cassel) will be found in *The Agricultural Ledger*. Speaking of the Jabbalpur district, more especially the Agaria ridge, these distinguished investigators say "the entire district undoubtedly contains considerable quantities of ferruginous material, but the latter is nowhere concentrated into what may be called a workable ore deposit showing the essential characters of steadiness and persistence which are indispensable in a deposit that is to form the basis of an important industry." The conclusion arrived at may be said to be that considerable though the iron resources of the district are, they are not such as would warrant the erection of iron and steel works with any prospect of commercial success. In the Mayurbhanj State, in Raipur and in the Chanda districts, Messrs. Tata, Sons & Co. of Bombay organised prospecting operations on a large scale and employed Mr. C. P. Perin and Mr. C. M. Weld as their experts. As a result it has been decided to erect iron and steel works near Kalimati on the Bengal-Nagpur Railway with the intention of using the Mayurbhanj ore in conjunction with fuel from the Jherria Coal Field. It may thus fairly well be assumed that this new departure marks an era in the metal industries of India.

Agaria Supply.

Chanda Supply.

A Company known as the Tata Iron and Steel Company, Ltd., was floated at Bombay in July 1907 with a capital of 2¼ lakhs of rupees. Since then Government have sanctioned the construction of a broad-gauge railway from Kalimati (the site selected for the works) to the ore-fields of Mayurbhanj State, a distance of about 45 miles. Coal lands have been purchased by the company in the Jherria field; limestone quarries secured near Katni; manganese ore is being opened up in Salaghat; designs for the works have been accepted and progress made in clearing the site for the erection of the blast furnaces which are expected to commence operations about the end of 1910.

Bengal.

Bengal.—It has, however, to be admitted that so far as actual results are concerned, the ore utilised in India is very nearly confined to that worked up by the Bengal Iron and Steel Company in its works at Barakar. In the *Review of Mineral Production*, Holland gives the ore raised in Bengal during 1898 to 1903, which shows for the six years an annual average output of 57,678 tons valued at £8,338, and a value per ton of 2·89*s*. Up to the present time, he observes, the Barakar Iron and Steel Company has manufactured pig-iron only, of which two blast furnaces have turned out 35,000 tons of pig-iron a year. Since then a third blast furnace has been added and an unsuccessful attempt made to manufacture basic steel. The history of past adversity and present prosperity of the Barakar works is the story of the failure of unskilled impersonal enterprise contrasted with skilled individual energy when combined with capital and commercial acumen. Their subsequent production was 65,115 tons in 1904; 97,698 tons in 1905; and 69,397 tons in 1906.

Pig-iron.
Blast Furnaces.

Foundries.

FOUNDRIES AND INDUSTRIES.—Iron and Brass Foundries are not separately returned, so that they have to be dealt with conjointly. They are scattered all over the country, but with the exception of the Barakar Iron and Steel Company, the railway and engineering workshops and foundries of Calcutta, Bombay, and certain other large towns, few are of any importance. In 1903 there were 78 foundries in all India giving employment to 22,568 persons, and in 1904, 89 employing 24,256 persons. Three years previously the corresponding figures were 70 and 17,980, so that there has been a considerable expansion; but these returns take, of course, no cognisance of the village blacksmith nor the workers in brass and copper. In the Records of the *Geological Survey of India* (1906, xxxiii., pt. i., 12–3) it is stated that the value of Bengal ore works out to an average of Rs. 2–4a. (3*s*.) per ton. For the rest of India, the ore being of a higher quality and raised at places often distant from the railways as well as the ports, a higher average prevails, say Rs. 4. The returns for 1904 show 71,608 tons of ore used, valued at £12,617. In the Central Provinces there were 441 small direct-process furnaces at work. [*Cf. Moral and Mat. Prog. Ind.*, 1905–6, 115.]

Persons Employed.

Cost.

Local Indents.

Local Manufactures.—The exports and re-exports are not of sufficient importance to necessitate separate treatment. A feature of great potentiality that bids fair to foster local manufacturing enterprise, is the decision of the Indian Railway Board to place Indian engineering firms in a position to tender publicly for a portion of the annual requirement of stock. The tenders are to be confined for the present to the supply of frames and bodies only, the requisite wheels, axles, springs and draw-bars to complete wagons being indented for from England as heretofore. Subject to the material being satisfactory, iron and steel of Indian manufacture should be used whenever possible.

Indigenous Industries.

Antiquity of Knowledge.

Material of Damascus Blades.

Indigenous Industries.—There would seem to be "no doubt that the existing manufacture of wrought iron by a direct process was widespread in the country before the date of the most ancient historic records, while the manufacture of the ancient *wootz* anticipated by many centuries the cementation process, developed in Europe, for the manufacture of the finest qualities of steel." "The Native iron-smelting industry has been practically stamped out by cheap imported iron and steel within range of the railways, but it still persists in the more remote parts of the Peninsula and in some parts of the Central Provinces has shown signs of slight improvement" (*Imp. Gaz.*, 1907, iii., 145). According to Mr. Syed Ali Belgrami, the Nizam's Dominions furnished the material from which the famous Damascus blades of the Middle Ages were made. To this day Hyderabad is noted for its swords and daggers. Holland observes that so far as official returns are concerned, the Central Provinces show the highest production of iron, viz. from 2,400 to 4,800 tons; but there is also a sensible industry surviving in Bijawar, Panna and Orchha amongst the Central Indian States, as well as in Mysore and in some parts of the Madras Presidency. "Steel is made, both in the form of ingots by the carburisation of wrought-iron in crucibles, and, on a much smaller scale, by the decarburisation of cast-iron shot in a small open hearth."

Iron Pillar, Kutab.

Arms.

Wrought Iron.

Carved Steel.

Damascening.

The antiquity of the Indian knowledge in iron may be judged of from the famous pillar at the Kutab near Delhi; from the numerous examples that exist of wrought iron; from the hammered and perforated door panels both in iron and brass to be seen at the ancient palaces and tombs; and from the superb collections of arms perserved by the princes and nobles. Burma has for many years been known to have attained high proficiency in wrought iron. Near the Arakan pagoda of Mandalay numerous workshops exist for the production of the iron *thees* or the umbrellas placed as weather-cocks on the pagodas of Burma. At the pagodas, balustrades in iron are also frequently used, and this demand has given birth to a fairly large import trade in very inferior cast-iron imitations of fine old Burmese designs in wrought iron. Of Western India, Baroda is noted for its wrought-iron balustrades. The engraving and carving of iron and steel was some years ago an important industry in India, and Kanara, Madura, Malabar, Vizagapatam and Mysore were famous for their works of this class. The art is still practised at Udaipur, Jaipur, and Jodhpur. Hyderabad, Deccan, and Kach are famed for their arms; and the gold and silver damascened soft-steel wares such as armour, swords, shields, caskets, etc. (*koftgari* work) of Sialkot, Serhoi, Jaipur, are traded in all over India and largely exported. The decline of the Sikh power and the modern change in the methods and materials of warfare struck, however, a deadly blow at the damascening art, and a serious decline both in the amount and quality of the work has for years past been manifest (*Ind. Art at Delhi*, 1903, 14-15, 460-2).

Trade.

TRADE.—Imports.—It is difficult to give anything like an accurate conception of the total traffic in iron. The local production is but imperfectly known; an error must therefore always exist. A large number of articles that are partly constructed of iron are sure to be returned under other headings, but the figures under hardware and cutlery, iron, steel, machinery, railway plant, rolling stock, locomotives, etc. (Merchandise and Government Stores), give some idea of the vast magni-

Imports.

Cast Iron.

Bar-iron.

Steel.

United Kingdom *versus* Belgium.

Pipes and Tubes.

Sheets and Plates.

tude of the traffic. The IMPORTS shown under these headings were collectively in 1899–1900 valued at Rs. 13,34,14,503; in 1901–2 at Rs. 15,11,06,431; in 1903–4, Rs. 19,58,09,778; in 1904–5, Rs. 20,30,66,366; in 1905–6, Rs. 23,01,10,532; and in 1906–7, Rs. 26,86,49,605 (£17,909,973). Thus the traffic is by no means unimportant, but it may be useful to direct attention to certain items of it that more especially may be called Iron. The imports of CAST-PIG were in 1899–1900, 263,563 cwt., valued at Rs. 7,95,040; in 1901–2, 291,422 cwt., valued at Rs. 8,73,347; in 1903–4, 531,953 cwt., valued at Rs. 13,84,888; in 1905–6, 636,163 cwt., valued at Rs. 16,17,966; and in 1906–7, 667,285 cwt., valued at Rs. 18,43,167. Practically the whole of these imports came from the United Kingdom, the only other country of importance being Aden. Of BAR-IRON, the imports were in 1899–1900, 499,678 cwt., Rs. 30,07,124; in 1901–2, 855,106 cwt., Rs. 49,67,024; in 1903–4, 650,409 cwt., Rs. 35,74,266; in 1905–6, 781,360 cwt., Rs. 39,89,004; and in 1906–7, 606,604 cwt., Rs. 35,18,998. Under the heading of STEEL-BARS the imports were in 1899–1900, 500,676 cwt., valued at Rs. 33,21,024; in 1901–2, 974,038 cwt., Rs. 54,93,840; in 1903–4, 1,115,933 cwt., Rs. 59,49,191; in 1905–6, 1,963,574 cwt., Rs. 95,42,895; and in 1906–7, 1,402,762 cwt., Rs. 74,92,013. In the iron and steel bar traffic Belgium has practically usurped the United Kingdom and for some years past poured into the country large quantities of cheap stuff that has found a ready and expanding market. Of PIPES and TUBES in 1899–1900 the imports were 257,118 cwt., Rs. 25,32,277; in 1901–2, 322,520 cwt., Rs. 29,40,404; 1903–4, 821,783 cwt., Rs. 57,81,098; 1905–6, 514,060 cwt., Rs. 38,19,850; and in 1906–7, 668,539 cwt., Rs. 51,17,286. In this traffic the British manufacturer more than holds his own, the only important competitor being the United States. Of SHEETS and PLATES (all kinds) the imports in 1899–1900 were 1,104,289 cwt., valued at Rs. 1,04,42,871; in 1901–2, 1,298,985 cwt., Rs. 1,22,15,307; in 1903–4, 1,636,592 cwt., Rs. 1,45,60,655; in 1905–6, 1,783,999 cwt., Rs. 1,59,41,040; and in 1906–7, 2,190,764 cwt., Rs. 2,20,45,396. The supplies come mainly from the United Kingdom, the only other country of importance being Belgium, the trade from which would appear to be declining.

Machinery and Railway Plant.

These illustrations may be accepted as fairly representative of all the special headings of the iron trade proper. Space cannot be afforded to indicate the traffic in the manufactures that are only partially made of iron, such as machinery, railway plant, etc. It may have been observed that a steady rise is taking place in the imports. Even the figures exemplified are sufficient to show that there is room for a large iron manufacturing industry; and when this is established, the production of rails, rolling stock and machinery would soon follow in the wake of the furnace and the foundry.

[*Cf.* BENGAL: Montgomery Martin, *Hist. E. Ind.*, 1807–13, ii., 175–6, 190–3, 261–7; *Agri. Ledg.*, 1900, No. 14; *Rept. Chief Inspect. of Mines in Ind.*, 1902, 27–8; *Rec. Geol. Surv. Ind.*, 1904, xxxi., 168–70; 1906, xxxiii., 12–3. CENTRAL PROVINCES: *Agri. Ledg.*, 1898, No 17; 1900, No. 14; Martin and Louis, *Native Methods of Smelting and Manufacturing Iron in Jabbalpur*, in *Agri. Ledg.*, 1904, No. 3. UNITED PROVINCES: Sowerby, *Rept. Surv. Iron Dept. in the Bhabur*, in *Sel. Rec. Govt. Ind.*, 1855, No. xvii.; Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 30; *Gaz. N.-W. Prov.*, 1882, x., 260–76. PANJÁB: Lawrence, *Valley of Kashmir*, 62–3, 372; *Rec. Geol. Surv. Ind.*, 1895, xxviii., 106. CENTRAL INDIA AND RAJPUTANA: *Rec. Geol. Surv. Ind.*, 1904, xxxi., 8–9. BOMBAY: *Rept. on Sample from Chota Udepur State, Imp. Inst. Bull.*, July 1903.

BALUCHISTAN : *Chrome-Iron*, in *Rept. Geol. Surv. Ind.*, 1902–3, xciv., 67 ; Fawcett, *Monog. Dyes and Dyeing*, 23, 32, 36. MADRAS : Heyne, *Tracts on Ind.*, 1814, 189–97, 218–26, 358–64 ; Holland, *Iron in S. Dist. Madras, Imp. Inst. Handbook*, 1892, No. 8 ; also *Iron Ores and Iron Indust. of the Dist. of Salem*, in *Rec. Geol. Surv. Ind.*, 1892, xxv., 135–59 ; Foote, *Mem. Geol. Surv. Ind.*, 1895, xxv., 191 ; Jeremiah Head, *Rept. Salem Ores and the Practicability of Conducting an Iron Indust. in that Dist.*, 1896 ; Dunstan, *Imp. Inst. Tech. Repts.*, 1903, 12–22. BURMA : Bose, *Rec. Geol. Surv. Ind.*, 1893, xxvi., 161–3; Stirling, in *Gaz. Burma.* UPPER BURMA : *Gaz.*, 1900, ii., 299–300.]

D.E.P.,
iv., 526–32
vi., pt. i.,
108.

ISCHÆMUM ANGUSTIFOLIUM, *Hack.* : *Fl. Br. Ind.*, vii., 129 ; *Kew Bull.*, 1888, 157–60 and t. ; GRAMINEÆ. The *baboi*, *bhabar*, *bhubt*, *bhaib*, *babni*, *sabai*, *baggar*, *ban-kush*, *bankas*, *som*, *moya*, *bachkron*, etc. A perennial grass plentiful in drier tracts of India, from Chota Nagpur and Rajmahal to Nepal and Garhwal, also throughout the plains northward, viz. in the Central Provinces, Central India and Rajputana to the Panjáb, Kashmir and Afghanistan, ascending to altitudes of 7,000 feet. The grass, from the most ancient times, has, in the localities where it abounds, been extensively used for making ropes, string and mats (see p. 776), and utilised in the construction of rope bridges, and to some extent takes the place of jute in agricultural sacking.

Mats.

Identification.

Bhabar is often associated with the sedge ***Eriophorum comosum*** (*D.E.P.*, iii., 266), and the two doubtless are sometimes used mixed together, but for many years it was incorrectly supposed that *bhabar* was ***Eriophorum***. Sir D. Brandis was the first to recognise that Royle, Wallich and others were in error in overlooking the grass ***Ischæmum*** as the most important, if not the true *bhabar*. Stewart (*Journ. Agri.-Hort. Soc. Ind.*, 1863, xiii., 293), while acknowledging his indebtedness for this correction, expressed the opinion that the grass should, in the future, play an important part as a paper material—he was thus apparently the first to suggest that use for the grass. Duthie led to a true identification botanically, and Sir George King pioneered the trade as a paper material (see pp. 865-8). In the Annual Report for the Botanic Gardens of Calcutta for 1893–4, he tells us that he had sent home, in 1873, samples of the grass to a paper-maker in Scotland, who reported favourably on it, and again in 1877 had furnished the late Mr. Routledge, through the India Office, with a consignment for experiment in Sunderland. Investigations were also made in India from 1882, the first by Mr. Deveria, and finally by the Bally Mills Company, Ltd., and others, until the grass became firmly established as a paper material.

Paper Material.

Supply.

The *Kew Bulletin* and the *Indian Forester* have devoted much attention to this subject for some years past, and the Annual Administration Reports of the Forest Department have recorded the measures taken to foster and extend production. [*Cf.* Gamble, *Ind. For.*, 1893, app., xix. ; Fischer, *Ind. For.*, Nov. 1903, xxix., 516.] The grass has thus been systematically placed before the public. It has, in consequence, become an assured paper material, restricted alone by the insufficiency of the supply. The attempt has accordingly been made to cultivate the plant in localities more accessible to the paper-mills, thereby lowering the ruinously heavy freight charges. More or less successful experiments of this kind have been conducted in Poona, Mysore, Hyderabad Deccan and in Hyderabad Sind. Systematic cultivation has also been undertaken in Manbhum, Birbhum and Murshidabad. In Poona it has been announced that the yield is 24 cwt. of dry grass per acre. It was, however, ascertained that when grown on soils of a better class than in its wild habitat or under warmer and moister conditions, it tends to flower too profusely, and this lowers its value as a paper material. A consignment sent in 1898 from Poona to London, by Woodrow, was accompanied with the statement that it could be delivered on board ship at Bombay at Rs. 40 per ton.

Cultivation.

Yield.

Cost.

Bengal.

As marking the progress made, the following jottings, taken from official and other publications, may be here given. In the Bengal Forest Department Report for 1895–6, we read that the grass had been fairly extensively planted in Sahibganj, and that the produce sold readily at 12 to 14 annas a maund, and fetched at the mills Rs. 1-4 to Rs. 1-7, the railway freight being not over

Pulp.

3 annas 5 pies a maund. Mr. Wild, while Conservator of Forests in Bengal, devoted much attention to the supply of paper materials to the Calcutta mills, and among other subjects took up the study of *bhabar*. He then wrote, "When it is understood that the Calcutta mills turn out 360 tons of paper a week, or an equivalent of, say, 500,000 maunds a year, there is room for wood pulp as well as grass. It is believed that a consignment of 200 tons of pulp left Calcutta for Glasgow in 1896, at £4 2*s*. per ton. If the cost could be reduced to £3 10*s*. per ton—and there seems no reason why it should not—it would, it is thought, compete with esparto. Surprise has been expressed that the planting community in India does not pay attention to the cultivation of grasses, etc., for paper-making. There is evidently profit in it, and what is more, with the output of paper mills increasing every year, the demand, for some time to come, will be expansive."

Mulberry Fields.

Calcutta Supply.

U. Prov. Supply.

In Murshidabad, according to Mr. B. C. Bose, Assistant Director of Agriculture, Bengal, it is now planted in clumps along the borders of mulberry fields. "Two cuttings are taken in the year, one in September and the other in March. With irrigation three or four crops can be had. This is at any rate the experience in Poona. The March crop is cut after the grass has flowered, and yields very inferior fibre. No steps are taken to remove the flower stalks, no doubt owing to the cost of picking them out. The September crop does not flower, and yields the best fibre. The people look upon the formation of the flower stalks as a necessary evil, which they have no means of checking." The Calcutta mills draw their supplies from Sahibganj, Chota Nagpur and Nepal (the Terai), the last mentioned having, in recent years, contributed fairly largely. The Report issued by the United Provinces and Oudh for 1898–9 affirmed the annual production to be 200,000 maunds. The cutting in these provinces is said to commence at the end of October. That supply is very largely made use of in cordage.

D.E.P., iv., 524–6. Isinglass.

ISINGLASS, GELATINE, GLUE AND GELOSE.—There are commonly said to be five classes of Cements:—(*a*) Calcareous (pp. 713–4); (*b*) Gelatinous (animal, p. 543); (*c*) Glutinous (vegetable, p. 293); (*d*) Resinous (see **Tachardia lacca**, p. 1063); and (*e*) Mixed Materials, non-resinous. With the first mentioned lime is essential, and they are collectively designated Mortars. Gelatine is prepared from animal flesh, bones, skins, hoofs and horns. It is a purer article than glue, which is made, as a rule, from the parings of hides and the refuse of the tan-yard generally. A mixture of glue and shellac is often used in India, the lac peventing the penetration of moisture, which softens and renders ordinary glue often useless. There is no chemical difference between gelatine, glue and isinglass. The purer transparent forms are used for culinary purposes. Fish-glue made from fish-bones is largely employed in India, and may be had all over the country, but no information exists as to the centres of production or the methods of manufacture. Edible Swallows' Nests may be described as Indian gelatine (see **Birds**, p. 138). Gelose is prepared from several ALGÆ, designated in India as *agar-agar*, and in European commerce as China Moss. The best-known example is *Gracilaria lichenoides* (*D.E.P.*, iv., 174–5). Numerous glutinous cements and pastes are in use in India, the commonest of all being made with the water obtained on boiling rice. [*Cf.* GLUE:—Hoey, *Monog. Trade and Manuf. N. Ind.*, 176–7; Notter and Firth, *Theory and Practice of Hygiene*, 1896, 808; *Journ. Soc. Chem. Indust.*, 1904, xxiii., 1189–92; ISINGLASS:—Day, *Sea Fish and Fisheries of Ind. and Burma*, app. cxl.–cxlv.]

D.E.P., iii., 208–27. Ivory.

IVORY AND THE MANUFACTURES THEREFROM

Birdwood, *Ind. Art. Indust.*, 1880, ii., 218; Mukharji, *Art Manuf. Ind.*, 1888, 148–50; Watt, *Ind. Art at Delhi*, 1903, 170–93.

THE ELEPHANT

Indian Elephant.

Kheddahs.

African Elephant.

ELEPHANT.—No account of Ivory would be complete without some mention of the ELEPHANT. In the *Dictionary* will be found a fairly detailed account of the Indian species. From the most ancient classic times this sagacious and most useful animal has been known, and the methods of capturing and taming it can hardly have been changed materially for the past two thousand years. The Hindu god *Ganesha* (son of *Siva*) is represented with an elephant's head on the body of a man. In the *Rig Veda* the elephant is the animal with a hand, and in the *Atharvan* he is the mightiest of animals. In the wars of the *Ramayana* and the *Mahabharata*, elephant corps were employed and Indra's Vahan is the elephant *Airavat*. According to Monier Williams (*Buddhism*, 23-4, 84, 525), the elephant is with the Buddhists the most sacred of animals. Among European writers, Megasthenes (300 B.C.), Strabo (25 B.C.), Arrian (*Indika*, 150 A.D.; ed. McCrindle, 213) and Ælian (250 A.D.) give full particulars regarding the manner of hunting and capturing the elephant, the degree of its domestication and its use in warfare. Strabo (xv., 1, 41–3, 704–7) gives a chapter on the *kheddahs* that might be read as an abridgment of Sanderson's corresponding chapter in *Thirteen Years Among the Wild Beasts of India.* The African elephant appears to have similarly been tamed, and the Carthaginians employed them as fighting animals. The inscription at Adule (recorded by Cosmas, 545 A.D.) alludes to this special use. [*Cf.* Vincent, *Periplus*, app., 56.] During the ascendency of the Roman Empire, elephants became quite common in Europe; but they ultimately disappeared, and for several centuries seem to have been altogether forgotten, and what is most significant, the African elephant, since the fall of Carthage, has hardly since been in such a complete state of domestication.

European Travellers.

The White Elephant.

Howdah.

Baber's Account.

Rearing and Domesticatio

Passing over a gap of several centuries, little is said even of the Indian elephant, till Abd-er-Razzak (*Narr. of Journ. in Ind.*, 1442, in *India in 15th Century*, (Major, transl.), 27, 36) described the elephants owned by the King of Vijayanagar near Bellary, and the method of capturing and taming them then prevalent. Nicolo Conti, speaking of Ava (*Travels in the East*, in *India in 15th Century*, 11-2, 37), alludes to the white elephant owned by the king. Athanasius Nikitin (*Travels in India in 15th Century*, 12) discusses the elephants seen by him. Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 125-31) gives a most graphic account of the city of Vijayanagar and vivifies the ruined elephant stables, which in their desolation are to-day objects of special inspection by the curious. Garcia de Orta published at Goa the first edition of the *Colloquies* (1563, xxi.), and in that work we are given the Arabic name *fil*, the Deccan name *ati*, the Kanarese *aceti*, the Malabar *ane*, and the Ethiopian *ytembo*. Mention is made of the large amount of African ivory annually imported into Cambay, and of the existence of wild elephants in Orissa, Bengal, Patna, Pegu, Martaban, Ceylon and Siam. This is followed by Acosta (*Tract. de las Drogas*, 1578, 417–48), who gives for the time when produced two admirable plates showing the wild and tame elephant with its war *howdah*. In the *Voyage of Linschoten*, some additional useful facts are told of Indian elephants. Baber (*Memoirs*, 1525 (Leyden and Erskine, transl.), 315–6) enumerates and briefly describes the animals and plants seen by him in India which he regarded as peculiar to that country, and assigns the first place to the elephant, which he speaks of as abundant in parts of the country where, during the memory of living man, no wild elephants have been known. Abul Fazl (*Ain-i-Akbari*, 1590 (Blochmann, transl.), 117, etc.) details the particulars of the Emperor's elephant stables, and of the rearing of that animal under domestication. Barbosa (*Coasts East Africa and Malabar* (ed. Hakl. Soc.), 167-8) furnishes an account of how elephants were caught in Ceylon and exported to India. Subsequent to the dates mentioned, many European authors have contributed to the stock of present-day knowledge regarding this most useful animal. [*Cf.* Pyrard, *Voy. E. Ind., etc.*, 1601 (ed. Hakl. Soc.), ii., 343–6; Clusius, *Hist. Exot. Pl.*, 1605, 166, 260; Terry, *Voy. E. Ind.*, 1622 (ed. 1777), 134 (gives a long and most interesting account of the domestication and uses of the elephant in India); Mandelslo, *Travels*, 1662, in Olearius, *Hist. Muscovy, etc.*, 51; Tavernier, *Travels Ind.*, 1676, ii., 161, 317; Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 45; Ovington, *Voy. Suratt*, 1689, 191–4; Fryer, *New Acc. E. Ind. and Pers.*, 1672–81, 35, 96, 211; Milburn, *Or. Comm.*, 1813, i., 63; etc., etc. For recent works consult citation given in the *D.E.P.*, iii., 208-9; also *Journ. Bomb. Nat. Hist. Soc.*, 1895–7, x., 133–5; *The Elephant in Burma*, 1897–8, xi., 322–6, 335; 1903, xiv., 151–5; Jardine, *Elephant Shooting*, xiv., 160–2; Blanford, *Fa. Br. Ind.* (*Mammalia*), 463–7.]

CAPTURE OF ELEPHANTS

Chief Localities.

Distribution.—The elephant frequents the forest-clad portions of India and Ceylon from about Dehra Dun in the north along the foot of the Himalaya to Assam, Chittagong, Burma, Siam and Cochin-China, also in the forests of the Deccan, the Western Ghats, Mysore and South India. As a rule the elephant does not ascend much above 5,000 feet, but in Manipur and the Naga hills (Japvo) it has been met with at close on 8,000 feet. The chief centres of capture are in Assam (Garo hills more especially), in Mysore and Ceylon. It is generally affirmed that while all the Indian elephants constitute but one species—apart from that of Africa—there are several very distinct races such as those of Nepal, Assam, Burma and Mysore. The Nepal animal is small and especially adapted for life in a hilly country; the Shan elephant is tall, massive and handsome, but like the Ceylon race is often tuskless. Those of Burma and Chittagong are small and well suited for hilly countries, while the Assam animal is large and massive, hence better adapted for hunting purposes. The Natives classify the recognised races into *kumeriah*, the royal or princely, the thoroughbred; *mírga*, a tightly built and long-legged, arched-backed animal, suggestive of the deer *mírga;* and *dwasála*, the intermediate of the two former and the ordinary domestic or working elephant, the *mírga* being used in quick marching.

Races.

Kheddahs.

In India the animal is caught purely and simply for domestic purposes and is never (as in Africa) ruthlessly destroyed on account of its ivory. It is now captured exclusively by the *kheddah* system, and never by the cruel methods in pits, etc., formerly pursued. But there seem indications that, far from being exterminated, the Indian elephant is increasing in a higher ratio than the captures, and that the time may come when it may be necessary to keep the multiplication under control, so as to protect the cultivation of the tracts adjacent to the forests.

Price.

The chief Indian mart where elephants are offered for sale appears to be Sonepoor, near Patna, the *mela* there held being some time in October or November. An elephant costs about £40 to capture, and may be sold for £150. A full-grown elephant will weigh from 3 to 3½ tons, and stand from 7½ to 9½ feet at the shoulders. It is an adult at twenty-five years (but a calf may be obtained at thirteen to sixteen years), and its full age is 120 years. The only pace of the elephant is the walk, capable of being increased to a fast shuffle of about fifteen miles an hour, but for short distances only; it can neither trot, canter nor gallop. It cannot jump, can never have all four feet off the ground at one time, and hence a trench 7 feet wide is to it impassable, though the step of a full-grown animal is 6½ feet. The elephant will eat 600 to 700 lb. of green fodder, but is usually under-fed, getting 250 to 400 lb., and is fed mainly on leaves and boughs of trees. Most of its ailments proceed from unsuitable or insufficient food.

Pace.

Food.

Ivory.

IVORY (ELEPHANT'S TOOTH).—Mention has been made of the fact that the Ceylon elephant has frequently no tusks. In India a tuskless male is called a *múkna*. The tusks of the Asiatic animal are considerably less valuable than the African. As a rule, the nearer the equator, the larger, finer and more expensive the ivory; but there are in addition many local manifestations. African ivory is closer in grain and not so liable to turn yellow nor to warp and split as the Indian; moreover, the ivory of the east coast of Africa is superior to that of the west. By "dead ivory" is meant ivory that has been found on the ground or

Equator.

African *versus* Indian.

stored for a considerable time, until it has lost the oil or gelatine that gives elasticity to "green ivory." All the finer and more expensive ivory carvings are, as a rule, done on the best African ivory; and even in inlaying, the hair lines are invariably in the bluish-white African article, the larger patches being in the dull chalky Indian quality. For the miscroscopic structure of ivory, consult Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 422–8).

Oldest Sample.

Perhaps one of the oldest samples of Indian ivory on record is that mentioned by Stein (*Ancient Khotan*, 1907, 209, 222, pl. xlviii). This was found in the Khotan oasis and dates from about the 8th century. As a curiosity, it may be mentioned that in the armouries of the Indian princes a large number of daggers will be found, the hafts of which are made of fossil or of walrus ivories. Some of these weapons have often histories that carry them back for one or more centuries; hence the traffic in conveying these special forms of ivory from Siberia or even from Greenland to India, mostly by tedious land routes, must have existed long anterior to the present methods and channels of commerce. For the microscopic appearances of the various fossil and other ivories, confer with Hanausek (*l.c.* 426–9).

Fossil Ivory.

Ivory Carving.

Centres of Ivory Carving, etc.—There are four localities in India and one in Burma that may be spoken of as specially noted for their artistic ivories. These are Delhi in the Panjáb, Murshidabad in Bengal, Mysore and Travancore in Madras, and Moulmein in Burma. Here and there all over the country ivory carving and ivory turnery are met with, but the five localities named produce by far the best work. The chief artistic workers in India are Hindus.

Turnery.

Ivory Turnery, though less artistic, is even more widespread than carving: in fact, most towns have a few workers of this class. Small articles are made by them, such as bracelets (bangles), chessmen, antimony boxes, etc, etc. Some of the better known localities are Agra, Alwar, Bikanir, Jodhpur (more especially Pali), Amritsar, Ludhiana, Patiala, Tippera, Tirupati, Godávari, etc. With the Sikh the use of a comb is almost a religious observance. It is no wonder, therefore, that in Amritsar and other towns of the Panjáb, ivory combs of great beauty are to be had. Here and there fabulous sums are expended on special chairs, ***howdahs*** and thrones made of ivory, or rather veneered with ivory; so also in the purchase of mats and fans woven by threads cut from the tusk. Ivory mats are often made at Delhi, Bharatpur, Murshidabad, Tippera, etc.

Combs.

Mats.

Inlaying.

Ivory Inlaying.—In many parts of India wood is inlaid with ivory, but there are three localities that are specially noted for the superiority of this class of work. These are Mysore in South India, Hoshiarpur in the Panjáb, and Monghyr in Bengal. Bone is sometimes used as an inferior substitute for ivory in inlaying.

Trade.

Exports.

Trade in Ivory.—The *EXPORTS* of Ivory (raw and manufactured) from India appear to have been declining for some years past. In 1876–7 they were valued at Rs. 55,582; in 1886–7 at Rs. 48,311; in 1896–7 at Rs. 60,501; but for the years 1901–7 have been Rs. 27,740 in 1901–2; Rs. 27,827 in 1902–3; Rs. 26,795 in 1903–4; Rs. 26,956 in 1904–5; Rs. 44,655 in 1905–6; and Rs. 49,583 in 1906–7. The *IMPORTS*, on the other hand, seem to fluctuate very greatly, but on the whole the supply of raw ivory seems to be declining and manufactures increasing. Thus the raw and manufactured ivory imported in 1876–7 were valued at Rs. 24,55,637 (raw accounting for Rs. 24,15,514); in 1886–7 the figures were Rs. 28,81,190 raw and Rs. 1,46,762 manufactured; ten years later (1896–7) the total of both kinds was only Rs. 23,19,229; and in 1903–4 the figures returned were raw ivory Rs. 18,20,766 and manufactured Rs. 2,35,809; in 1905–6, raw Rs. 14,52,379, and manufactured Rs. 2,41,699; and in 1906–7, raw Rs. 12,71,754, and manufactured Rs. 2,24,984.

Fish Tooth.

Thus India is by no means self-supporting in the matter of ivory, but, as shown above, it has for several centuries procured large supplies from Africa. In Indian commerce ivory is spoken of as "elephant's tooth," but a second substance is called "fish tooth." This is of a dirty oily yellow colour, with the texture looking as if crystallised into patches. The significance of being called in every language of India by the same name is suggestive of a foreign origin. It is, as already explained, highly valued for sword and dagger hafts, and is more extensively so used than ordinary ivory. It would appear to be mainly if not entirely the so-called fossil ivory of Siberia—the ivory of the mammoth—a substance that has lain for countless ages in the frostbound drifts of Liakoff and New Siberia. It is also just possible that a fair proportion of the *machlá-ka-dant* of India is hippopotamus or even walrus ivory, the latter, along with fossil ivory, having found its way to India across the land frontier. In fact, from the antiquity of the daggers, etc, with fish-tooth hafts, it seems highly probable that the traffic in the commodity mentioned was a very ancient one—alone destroyed by the growth of fire-arms.

[*Cf. Monographs, Ivory Carving*:—Dutt, *Bengal*, 1901; Stubbs, *U. Prov.*, 1900; Ellis, *Pb.*, 1900; Burns, *Bombay*, 1900; Donald, *Assam*, 1900; Thurston, *Madras*, 1901; Pratt, *Burma*, 1901; Maskell, *Cantor Lect. on Ivory*, in *Journ. Soc. Arts*, Nov. 2, 1906, liv., 1127–42 *et seq.*; *Journ. Ind. Art* (many passages).]

J

D.E.P., iv., 545-9.
Physic Nut.

JATROPHA, *Linn.*; *Fl. Br. Ind.*, v., 382–4; Gamble, *Man. Ind. Timbs.*, 1902, 612–3; Talbot, *List. Trees, etc.*, 1902, 309–10; Prain, *Beng. Plants*, 1903, ii., 941; Brandis, *Ind. Trees*, 1906, 576; EUPHORBIACEÆ. A genus of woody plants, chiefly natives of America. Four species are indigenous to India and three others naturalised or cultivated.

J. Curcas, *Linn.*; *Rec. Bot. Surv. Ind.*, iii., 101, 275. The Physic Nut, *bagberenda, safed arand, rattanjot, magalicranda, kaat-amunak, thinbaw-kyetsu*, etc. An evergreen shrub, indigenous to America, but cultivated in most parts of India.

Juice.
Oil.
Seed.
Leaves.

Garcia de Orta (1563, *Coll.*, xviii.) describes certain seeds which he calls *curcas*, but it is perhaps doubtful if he refers to the seeds of the present species. [*Cf.* Ball, *Rev. of Garcia de Orta* in *Proc. Roy. Ir. Acad.*, ser. 3, 1889–91, i., 405.] Heyne regards the milk of this plant as possessing "the exclusive property" of "oxydating silver." When dried in the sun the juice forms a reddish brown, brittle substance like shellac or kino, and is also stated to dye linen black. The seeds yield about 30 per cent. of a pale yellow oil, incorrectly known as Croton Oil, which is used for burning, in medicine as a purgative and emetic, and as an application in cutaneous diseases. It has also been recommended as a substitute for olive oil, in dressing of woollen cloths, and as a good drying oil. Numerous cases of poisoning are on record through eating the entire seed, though used by the Natives as a purgative. Gamble states that in Madras the fruit is sometimes collected and sold, and in Assam the leaves are occasionally used to feed the *eri* silkworm, when other leaves are not available. [*Cf.* Heyne, *Tracts on Ind.*, 1814, 242, 245; *Pharmacog. Ind.*, 1893, iii., 274; Nicholls, *Textbook Trop. Agri.*, 1892, 205; Henry, *Econ. Bot. China*, 1893, 61; Kirtikar, *Poison. Pl. Bomb.*, 1896, i., 59; Waring, *Bazar Med.*, 1897, 124–5; Woodrow, *Gard. in Ind.*, 1899, 442; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 417.]

Dye.
Medicine.

J. glandulifera, *Roxb.; lál-bherenda, undarbibi, addalai, dundigapu,* etc. A small shrub common throughout the hotter damp tracts of India, often grown as a hedge. Reputed to produce a green dye. The seeds afford a light yellow fluid oil, which has for long been used as an external application in rheumatism and paralytic affections, but is seldom administered internally, though spoken of as a purgative. [*Cf. Pharmacog. Ind.*, 1892, iii., 272–3.]

D.E.P.,
iv., 549–52.
Walnut.

JUGLANS REGIA, *Linn.*: *Fl. Br. Ind.*, v., 595; Gamble, *Man. Ind. Timbs.*, 662–3; Brandis, *Ind. Trees*, 619–20; JUGLANDEÆ. The Walnut Tree, *akhrót, ákhor, kabshing, kól, dún, ughz, thitcha,* etc. A large deciduous tree of the Himalayan forests from Afghanistan to Bhutan at 3,000 to 10,000 feet, and the hills of Upper Burma; also cultivated on the Himalaya, the Khasia hills, and occasionally in gardens on other temperate tracts.

Timber.
Burrs.
Dye.
Medicine.
Food.
Oil.

The utilisation of the walnut and, accordingly, its cultivation in India date from very remote times. Its chief value lies in its timber. The most important use of the wood is for gunstocks, and as the European supply is becoming exhausted, Gamble points out that it is a matter for serious consideration whether the tree should not be more extensively and systematically cultivated in India. In Kashmir and throughout the Panjáb it is used for ornamental carving, turnery and fancy work. The average weight is about 44 lb. per cubic foot. The huge warts or "burrs" growing on the stem are also exceedingly valuable, the wood of which is prized by cabinet-makers for veneer work. It is said that a good burr may be valued at about 20*s*. per cubic foot. These burrs have at times been largely exported from Kashmir to France, and Lawrence (*Valley of Kashmir*, 1895, 352–4) mentions that in one year countless numbers of trees were destroyed by cutting out the burrs, for which a large demand then existed. The bark is employed as a DYE and MEDICINE and is exported to the plains, where it is used for cleaning the teeth. The fruit, which ripens in July to September, is an important article of food in Kashmir and the North-West Himalaya generally and is largely exported to the plains. The kernel yields a good description of oil, while the rind is employed for tanning and dyeing. Lastly, the twigs and leaves are utilised as FODDER. [*Cf.* Moorcroft, *Travels Himal.*, 1841, ii., 145–50; Bentham, *Rev. of Targioni-Tozzetti* in *Journ. Hort. Soc.*, 1855, ix., 166; De Candolle, *Orig. Cult. Plants*, 1884, 425–7; *Ind. For.* 1892, xviii., 383–5; 1896, xxii., 48; Henry, *Econ. Bot. China*, 1893, 48; *Agri. Ledg.*, 1902, No. 1, 54; *For. Admin. Repts.*]

L

D.E.P.,
iv., 580–1.
Calabash.

LAGENARIA VULGARIS, *Seringe*: *Fl. Br. Ind.*, ii., 613; Duthie and Fuller, *Field and Garden Crops*, 1883, ii., 48–9, t. xlviii; Duthie, *Fl. Upper Gang. Plain*, 1903, 365–6; Cooke, *Fl. Pres. Bomb.*, 1903, i., 516–7; Prain, *Beng. Plants*, 1903, i., 519; CUCURBITACEÆ. The *kaddu, lauki, tumri, kodu, tikta láu, tumba, iráo, kundánuga,* etc. A climbing plant found wild in India, the Moluccas and Abyssinia. As a result of cultivation the fruit assumes many different forms, the best known of which are the Pilgrim's Gourd, the Bottle Gourd, the Trumpet Gourd, and the Calabash.

Fruit.
Oil Bottles.

This plant is extensively grown in many parts of India for its FRUIT and succeeds best on heavily manured soil. Sowing may take place as early as February or as late as July, but for rainy-season crops two sowings are made, the first in April, the second in June. It is best to sow the seed where the plants are to grow, and about six feet should be left between each. The cultivated forms are all eaten both by Europeans and Natives. By the former, the fruit is boiled when young and used as a vegetable marrow; by the latter it is sliced and cooked in curry, or the pulp is eaten with vinegar or mixed with rice. The dried shell of the bottle-shaped gourd is used by the Natives for holding water or as oil bottles, while the small wild form, *tumri*, is used for making the stringed instrument, the *sitar*, and the wind instrument, *bin*. The seeds yield a clear, limpid Oil which is medicinal. The pulp of both the wild and the cultivated forms, as also the leaves, are purgative. [*Cf.* Asa Gray, *Scient. Papers*, 1889, i., 330-2; Basu, *Agri. Lohardaga*, 1890, pt. 1, 78-9; *Pharmacog. Ind.*, ii., 67-8; Gollan, *Ind. Veg. Gard.*, 1892, 116; Banerjei, *Agri. Cuttack*, 1893, 115; Woodrow, *Gard. in Ind.*, 1899, 331; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 168-9.]

Oil.

LAGERSTRŒMIA, *Linn.*; *Fl. Br. Ind.*, ii., 575-8; Gamble, *Man. Ind. Timbs.*, 371-6; Talbot, *List Trees, etc.*, 1902, 175-6; Cooke, *Fl. Pres. Bomb.*, 1903, i., 512-4; Brandis, *Ind. Trees*, 337-40; LYTHRACEÆ. A genus of trees or shrubs containing 18 species—natives of South-East Asia. Burma may be spoken of as the centre of the genus.

D.E.P., iv., 581-4.

L. Flos-Reginæ, *Retz.*; *Rec. Bot. Surv. Ind.*, iii., 213. The *jarúl, ajhar, taman, kadali, adamboe, eikmwe, pyinma*, etc. "The chief timber-tree of Assam, Eastern Bengal and Chittagong, and one of the most important trees of Burma." It also occurs in Chota Nagpur, the Circars and the west coast from the South Konkan southwards. It is commonly cultivated as an avenue tree. Is chiefly found along river-banks and on low swampy ground, but occurs only sporadically.

No special care is taken to propagate the plant. It is ready to be felled when thirty to fifty years of age. The timber is used for shipbuilding, boats and canoes; for construction of carts, etc. It has also been employed for gun-carriages and was recommended for gunstocks, but the report on the experiments so far made has been unfavourable. In South India it is used for building and in Ceylon for casks. It is said to be very durable under water, but to decay soon when under ground. Hope (*Jarul Timber, Ind. For.*, 1885, xi., 373-6), however, condemns the wood as not being durable and as being too readily attacked by white ants, but Gamble remarks that it is not quite certain the wood Hope refers to was in reality that of this tree. The average weight varies from about 40 to 45 lb. per cubic foot. A report is given by Unwin (in *Imp. Inst. Tech. Repts.*, 292-3; also in *Agri. Ledg.*, 1897, No. 9, 181-3) on various mechanical tests made on a block of this timber. He gives the following results:—weight, 41·77 lb. per cubic foot; resistance to shearing along the fibres, 832·4 lb. per sq. inch; coefficient of transverse strength, 5·22 tons per sq. inch; coefficient of elasticity, 544·1 tons per sq. inch; crushing strength, 2·762 tons per sq. inch.

Timber.

There appears to be no trade in this timber carried on in the provinces of India, except Assam. Of the Garo hills it is said that all the timber removed is exported to Bengal, and that the price of a standing tree is Rs. 6. In Cachar about 20,000 cubic feet are exported yearly to various places in the Sylhet district, and the price averages Rs. 1-2 per cubic foot. [*Cf.* Unwin, in *Ind. For.*, 1898, xxiv., 89-91; Woodrow, *Gard. in Ind.*, 1899, 318; *Agri. Ledg.*, 1902, No. 1, 43.]

Trade.

L. parviflora, *Roxb.*; Duthie, *Fl. Upper Gang. Plain*, 1903, 353; *Rec. Bot. Surv. Ind.*, 1904, iii., 59. The *bákli, sida, dhaura, nana, bondára, chenangi, tsambelai, zaung bale*, etc. A large deciduous tree common almost all over India, except in very dry regions. It is of considerable economic importance since the timber is in demand for general purposes such as house-posts, beams and rafters, door and window frames, agricultural implements, carts and boats. It also yields a good charcoal. The average weight is about 53 lb. per cubic foot. The bark has been employed in tanning and as a black colouring agent. It also yields a fibre used in Chota Nagpur for ropes, and the gum is said to be sweet and edible. The tree is one of those on which the *tasar* silkworm is reared.

Timber.

Fibre.

Gum.

LARD AND TALLOW.—The rendered fat of the pig forms the valuable commercial product Lard. A similar substance prepared from cattle and sheep is Tallow (see **Live Stock**, p. 754; also **Oils**, pp. 813-4, 819). Space cannot be afforded to deal with these substances separately. Speaking of lard, the best is the so-called Leaf Lard. This is derived from the fat surrounding the kidneys, and from the flaky layers below the skin. In European trade two other qualities are prepared from the softer and more fusible parts of the fat, and are known as second and third quality lard.

D.E.P., iv., 254, Hog; v., 450-2, 459-60.

Lard.

Lard.—The following information regarding the manufacture in Calcutta

Two Kinds of Pigs.

Rendering House.

Preparation.

Durability.

is communicated by Mr. I. H. Burkill, from information derived from Mr. S. Francis, superintendent of the pig slaughterhouse, Calcutta. Formerly lard was made by three large firms and several small houses, but lard-rendering is now carried on by a few small Native concerns only, and these are situated round the municipal pig slaughterhouse. With the disappearance of large and responsible firms, the quality of the lard has degenerated. The manufacture goes on all the year, but the beginning of the hot weather is the busiest season, because then most pigs are brought in. Two kinds of pig are slaughtered; one, bred in Calcutta, is called the "China-pig"; the other, driven in from the villages of Bengal, is called the "country pig." The former is white, the latter black. The animals are slaughtered in the early hours of the morning and lard-rendering begins in the forenoon. The rendering house consists of a small room and a larger godown, where the lard is cooled and stored. The rendering is done in an iron pan about two feet across and eight inches deep, placed over a slow fire. Scraps of fat of all shapes, but none weighing more than three or four ounces, are washed in water for about two hours and then heaped up in the pan to above the level of the rim. When the lard is thoroughly melted it is poured out of the pan through a double thickness of cotton-muslin into an earthenware vessel, where it stands to set. Several times a day during setting it is stirred gently for about half an hour. The time taken in setting varies with the nature of the animal from which the fat has been obtained. Lard from the "China pig" takes about two days to set, that from the "country pig" a much less time, and the lard is of better quality. Lard thus manufactured will keep for about two months only, but formerly for a much longer time—a circumstance due apparently to the fact that fat of the freshest and best quality is not always used.

Best Quality (Cooking).
Second (Oil).
Third (Soap).

The best quality of lard is much used in cooking and in preparing ointments, etc., the second in the manufacture of lard oil, the third as a low-grade oil in soap-making. The oil is manufactured by exposing the lard in woollen bags between wickerwork to a pressure of about ten cwt. a square inch in the cold for about eighteen hours. The oleine thus obtained is pure, colourless and limpid. It is employed as an adulterant for olive oil in France, and for sperm oil in the Eastern States of America. It is also esteemed as a lubricant and is used for illuminating. In MEDICINE, lard has long held the principal place as a medium for the exhibition of other substances, as ointments, etc. As an external application it possesses emollient properties, and is extensively employed in external inflammations, bruises, sprains, and in various skin eruptions.

Tallow.

Rendering.
Soap.
Candles.

Tallow, as already stated, is prepared from beef or mutton and goat fat, or a mixture of these. It is a harder and less fusible fat than lard. The rendered tallow is refined by boiling with water; is often bleached by means of nitric acid, and employed as a lubricant and for soap and candle making. When intended to make moulded tallow-candles, the finest mutton suet can alone be used, but for "dips" the refuse from the moulded candles or the cheapest tallow (a mixture of all animal fats) may be employed. Hoey (*Monog. Trade and Manuf. N. Ind.*, 174) speaks of the candle-makers of Lucknow using *charbí* (fat), but though he deals most minutely with the industries of that city, he makes no reference to the lard and tallow manufactures. So again, speaking of soap manufactures, he states that *charbí* (bullock and buffalo fat and *tel*, either castor or linseed) is employed.

Trade: Lard. Exports. Imports. **Tallow.** Exports. Imports.

Trade in Lard and Tallow.—The foreign traffic in LARD appears to be declining. The *EXPORTS* in 1876–7 were valued at Rs. 3,22,825; in 1886–7, Rs. 1,93,823; in 1896–7, Rs. 67,900; and for the past five years they have been:—1902–3, Rs. 52,810; 1903–4, Rs. 30,526; 1904–5, Rs. 15,500; 1905–6, Rs. 18,750; and 1906–7, Rs. 15,747. Corresponding with this change in the traffic, the *IMPORTS* may be said to manifest an expansion: in 1899 they were valued at Rs. 26,952; in 1900–1 at Rs. 47,058; and for the past five years have been:—1902–3, Rs. 61,462; 1903–4, Rs. 70,610; 1904–5, Rs. 55,454; 1905–6, Rs. 59,536; and 1906–7, Rs. 92,370. The traffic in TALLOW corresponding to the lard just given was as follows:—*EXPORTS* were in 1876–7 valued at Rs. 31,234; 1886–7, Rs. 54,097; 1896–7, Rs. 95,574; and during the five years ending 1906–7 were valued at Rs. 1,70,721, Rs. 2,17,828, Rs. 1,30,999, Rs. 1,11,255, and Rs. 80,404. Thus it may be said this export traffic is, on the whole, an expansion. The *IMPORTS* in 1876–7 were valued at Rs. 62,671, and for the past seven years have been:—1900–1, Rs. 3,46,570; 1901–2, Rs. 5,51,976; 1902–3, Rs. 3,84,402; 1903–4, Rs. 5,93,127; 1904–5, Rs. 6,80,054; 1905–6, Rs. 8,16,705; and 1906–7, Rs. 9,14,834.

Bengal. Burma Demand.

Nearly the whole of the Lard exported from India goes from Bengal to Mauritius. Formerly a fair amount was consigned to Reunion and to the Straits Settlements, but for some years past both these countries have discontinued their demands. India, as shown above, imports lard, and by far the major supply comes from the Straits, and recently from China (Hongkong), but Burma may be described as the receiving province. Of the total imports in 1903–4, viz. 316,111 lb. (the largest quantity for the past five years), valued at Rs. 70,610, Burma alone took 303,727 lb., valued at Rs. 65,203. The returns of the coastwise traffic do not show lard separately from "Other Provisions," so that it is not possible to discover to what extent Bengal or the other provinces of India are competing with the Straits for a share in the Burmese market.

Bombay. Large Imports.

Speaking of the traffic in TALLOW, it is curious that while Bengal is the province most concerned in lard, the tallow traffic is concentrated chiefly in Bombay. The foreign EXPORTS in 1906–7 were 4,135 cwt., valued at Rs. 80,404, of which Bombay exported 3,517 cwt., valued at Rs. 69,601. Of the receiving countries, Arabia seems to manifest the most constant demand, taking 2,260 cwt. out of the total. IMPORTS.—A curious feature of the tallow traffic may now be mentioned, namely that Bombay, followed by Burma, takes by far the largest share of the foreign supply. During 1906–7 India imported tallow to the extent of 36,837 cwt., valued at Rs. 9,14,834, and of these amounts Bombay took 23,325 cwt., Burma 6,433 cwt. The countries of supply were the United Kingdom, 19,604 cwt., and Belgium, 6,288 cwt. There is no mention of re-exports, so that India would appear to be by no means self-supporting in its lard and tallow supplies. [*Cf.* Hurst, *Lubric. Oils, Fats, etc.*, 1896, 180; also *Soaps*, 1898, 119–20; Blyth, *Food Compos. and Anal.*, 1903, 310–6; Leach, *Food Inspect. and Anal.*, 1905, 451–6).]

D.E.P., iv., 590–4. Chickling-Vetch.

LATHYRUS SATIVUS, *Linn.*; *Fl. Br. Ind.*, ii., 179–80; Duthie and Fuller, *Field and Garden Crops*, 1883, ii., 15, t. 32; Church, *Food-Grains of Ind.*, 132, t. 24; *Rec. Bot. Surv. Ind.*, i., 41, 151: ii., 48, 96; iii., 192; Duthie, *Fl. Upper Gang. Plain*, 260; Cooke, *Fl. Pres. Bomb.*, 1903, i., 360; LEGUMINOSÆ. The Chickling-Vetch, *khesári*, *latri*, *teora, tiura, churál, lákh* (or *lác*), *lakhóri, láng,* etc. An annual herb which, according to De Candolle, is indigenous to the region that extends from the Caucasus to Northern India.

Cultivation.

Dry *Rabi* Crop.

Chief Areas.

Cultivation and Area, etc.—This vetch is cultivated throughout India as a cold-weather crop, and has the reputation of germinating on land too dry for other *rabí* crops. To this fact is largely due its value agriculturally. It can take the place of other crops when the October rain has failed, and as an article of food it is remarkably cheap. Statistics of actual cultivation are not available for the whole of India, so that a complete statement of the total area cannot be furnished. The following particulars of a few provinces are, however, instructive. In 1904–5 the CENTRAL PROVINCES had an area of 363,504 acres, chiefly in Nagpur (163,632 acres) and Chhattisgarh (152,046 acres) districts. BERAR appears to have had 14,408 acres. BOMBAY (excluding Sind) 18,656 acres, mainly in Broach. SIND by itself had 232,070 acres, chiefly in Larkhana district (142,014 acres). The UNITED PROVINCES do not appear to have published the area recently, but some few years ago the acreage devoted to the crop was said to have been 56,100 acres. No returns of any kind are available for Bengal, Assam, Burma, the Panjáb, Rajputana and Central India, nor Madras. There is no evidence, however, that these provinces materially affect the total Indian production. The two chief areas are the Central Provinces and Sind.

Tillage.

Soils.

Season.

Seed.

Cost.

Fodder.

Food.

Tillage and Yield.—To give some conception of the methods of cultivation, yield, etc., of this pulse, the admirable account given by Mollison (*Textbook Ind. Agri.*, 1901, ii., 29; iii., 78–80) may be here drawn upon. *Láng*, he says, is almost invariably grown alone, though a slight admixture may be found in gram (***Cicer arietinum***) fields. It thrives best on deep, retentive, black soils. In the Deccan it is chiefly a second crop in rice-fields, but in Gujarat it is the sole crop of the year. In Broach it is generally raised on low-lying fields liable to be flooded by heavy rain, all fields which become waterlogged and too wet for cotton being commonly sown with *láng*. Tillage operations begin by ploughing after the first fall of rain. If the rains are unfavourable for cotton, the field is kept for *láng* and repeatedly harrowed during July, August and September. No manure is applied, but the ground is carefully prepared, since *láng* grown on clean ground is a good preparation for cotton in the succeeding year. Sowing takes place in September or early in October, and the seed-rate varies from 35 to 40 lb. per acre. The seed is dropped in the plough furrows in rows about a foot apart, and the surface levelled and pressed immediately after. No weeding is required, and the crop ripens in February about four and a half months after sowing. It is reaped before it is fully ripe, formed into small heaps in the field, and allowed to dry for a week. When dry it is threshed out under the feet of bullocks and winnowed in the ordinary way. The cost of cultivation is stated to be Rs. 13–12 per acre. In a well-grown crop the weight of pulse almost equals the weight of fodder. From full average crops in Broach, Mollison found the outturn of pulse to vary from 925 lb. to 1,068 lb. per acre, and of fodder from 1,220 lb. to 1,405 lb. *Láng* is cultivated chiefly as a FODDER, but as it is cheap and easily grown, it is considerably used as FOOD by the poorer classes, principally in the form of bread, *dál*, or porridge.

Paralysis and Lathyrism.

Evil Reputation.—Much interest has been, for a century or more, spasmodically directed to this pulse, on account of its evil reputation of causing paralysis of the lower extremities, when eaten continuously for any length of time. But it might be said that the whole family of LEGUMINOSÆ, much as we use them, are in some respects a suspicious family. A few years ago I gave attention to this particular pulse, and in consequence placed before the members of the Medical Congress of Calcutta (1894) the results of my inquiry. I then pointed out that it exists in two sizes, the smaller form being known in Chhattisgarh as *lákhóri* and the larger in Nagpur and Bhandara as *lákh*. The former is sown earlier than the latter. Its seeds are broadcasted over the flooded rice-fields (towards the close of the rains), while the latter is sown on rich black, dry soils, on land ordinarily devoted to wheat. The opinion seemed universal that while the *lakhori* or rice-field cultivation yielded a harmless seed, the *lakh* or wheat-field crop was very dangerous. There would appear to be no botanical characteristics to account for this remarkable difference.

Two Distinct Races.

Speaking on the dangerous property of this pulse, Major A. Buchanan, I.M.S., who has given the subject much careful study (*Lathyrism Rept.*, 1904, 25), says, "Continued growth of rice-land *teora* on rice land has produced a different race. At any rate it is easy as a rule to distinguish a heap of *lakh* from a heap of *lakhori*, but there might be a difficulty in distinguishing single seeds of the two kinds. The wheat-land *teora* or *lakh* is as a rule larger." "The weights of a hundred seeds of *lakh* varied between 245 and 110 grains, the weights of *lakhori* varied between 108 and 77 grains. The colour of the wheat-land *teora* is darker than the colour of the rice-land *teora*. The latter is called the yellow *latri* in Azamgarh." In that district the people consider that the yellow *latri* is non-poisonous, and the people of Bhandara have for many years held the same opinion. For our present purpose it may, therefore, suffice to thus indicate the two crops met with in India.

Rice- and Wheat-land. Crops.

Properties of the Pulse. Sir J. B. Fuller, while Commissioner of Jabbalpur, suggested that the greater care taken by the people of Chhattisgarh in cooking this grain might account for their partial immunity from toxic action. The grain, he explained, is in Raipur commonly parched before being ground, and the husk of the grain is, moreover, separated and not eaten. This causes a loss of 25 per cent. in the weight—a loss which those in poverty are naturally averse to sustaining. The flour thus prepared is next baked into cakes (*chapattis*), or boiled with buttermilk into a paste known as *mahera*. This suggestion led to the supposition that the poison might consist of some volatile substance expelled by the dry heat, or that it resided in the husk. Mr. Cleveland suggested that *tiura* loses its poisonous qualities when eaten along with *mahua* (the flowers of ***Bassia latifolia***). So also many years ago Dr. Kinloch Kirk pointed out that rice to be completely wholesome must be kept for some time. The best rices are three years old. Rice under-kept boils thick and becomes gummy, and is not wholesome. Hence it has been argued that the age of the *lakh* grain may similarly have something to say to its poisonous property.

Cooking and Toxic Action.

Flour. Cakes.

Influence of Age.

The following chemical analysis of the pulse is given by Church (*l.c.*, suppl., 13):—water 11·1, albuminoids 24·4, starch, etc. 55·3, oil 1·0, fibre 5·4, ash 2·8. The nutrient ratio is here 1 : 2·3 and the nutrient value 82.

Chemical Composition.

Lathyrism.—Mention has already been made of the fact that it has for long been known that a form of paralysis, to which the name *Lathyrism* has been applied, is believed to result when this pulse is eaten continuously for some length of time. One peculiarity of the disease (in men) is that it affects adult males chiefly (1 in 10). Another, that it is the lower extremities that become paralysed. But similar results are produced when the pulse is given to horses, cattle, pigs. Investigations have been conducted at the Imperial Institute with a view to ascertain the nature of the poison, but the results so far attained have been entirely negative. The poisonous property, we are assured, is not due (as has been supposed) to a volatile alkaloid that might be dissipated by superior methods of cooking, nor to any ordinary chemical poison. Dunstan has very properly pointed out that it is by no means certain that the seeds sent to Europe for examination were actually those of the poisonous sort. But it may have been inferred from the observations already made that we have no simple method by which to ascertain when the seeds are or are not poisonous, and can but procure supplies from localities where the paralysis mentioned prevails. In no instance does the poison exist in such abundance as to give immediate indication of its presence. It is only after protracted consumption that the paralysis appears. In fact there would even seem grounds for suspecting that the plant may only be intermittently poisonous, so that no particular race or crop could be

Special Characteristics.

Poison not Proved.

pointed out as *the* poisonous seed. The subject has been approached at the instance of the Imperial Institute from another point of view, namely investigations to ascertain if the pulse possesses a poisonous fungal parasite that could account for the toxic action. Prof. Percival, of the Wye Agricultural College, failed to discover any such fungus.

General Conclusions.

Predisposes to Paralysis.

Recently the disease has been very prevalent in the Central Provinces, and a census showed that the number of people more or less paralysed was over 7,600. In view of this fact Major Buchanan was put on special duty to inquire into the cause of the spread of lathyrism, and to endeavour to find means for its prevention. The results of his investigations are embodied in a bulky report (to which reference has already been made). He gives the following general summary :—" It has been shown that lathyrism is due to the consumption of ***Lathyrus*** ; that the disease, when it occurs in big epidemics, follows famine or scarcity ; that it is chiefly confined to wheat-growing areas ; that failure in wheat is an important factor in the causation ; that the disease is chiefly found among the poor, and that debt is an important factor in the causation. Under certain circumstances ***Lathyrus*** is a good article of diet, and it is only when the proportion reaches or exceeds one-half of the whole ration that paralysis is likely to occur." On the other hand, Dr. A. G. Hendley (*Brit. Med. Journ.*, 1903, ii., 707-9), after discussing fully this subject, arrives at the conclusion that "***Lathyrus***, whilst it may possibly cause paralysis by itself, ordinarily only predisposes to it, that it makes the subject ready or ripe for the attack of paralysis, but that exposure to severe wet and cold is required actually to excite the sudden seizure." " The attack occurs after an unusually thorough wetting whilst ploughing, watching crops at night or other field work that ordinarily falls to man's lot and not woman's."

Trade

Confused with Grey Peas.

Trade.—No particulars can be furnished of the trade in this pulse. It is known to be occasionally exported. Some few years ago a sample of what was called " *mútar*, or Indian Grey Peas " was shown to me by a Glasgow corn-merchant. I pointed out that while this pulse was ocsionally called *mattar*, the true *mattar* of India was the Grey or Field Pea. It is, therefore, most important that the present pulse should not be confused with the grey pea of India, which is as harmless and useful as the grey pea of Europe. The wedge-shaped pea of the present plant, flattened on two sides and marbled on the surface, should easily be distinguishable from all the peas or pulses of India, except perhaps gram (***Cicer arietinum***) ; but while gram is somewhat triangular in section it is prominently tapered below into a beak, and is devoid of the marbling of ***Lathyrus***.

[*Cf.* Kinloch Kirk, in *Ann. Med. Sc.*, 1870, vii., 144–52 ; *Pharmacog. Ind.*, i., 490-1 ; Banerjei, *Agri. Cuttack*, 1893, 81 ; Voelcker, *Poison. Legum. Seed in Ind. Peas*, *Analyst*, March 7, 1894, 102–7 ; Hughes, *Feeding Exper. with Ind. Peas*, Aug. 1895, 169-73 ; *Ind. Mus. Ann. Rept.*, 1894–5, 36-7 ; *Ind. Med. Gaz.*, 1898, xxxiii., 147 ; 1899, xxxiv., 65 ; Barclay, *Agri., Ledg.*, 1895, No. 20, 381–2 ; *Brit. Med. Journ.*, 1899, i., 1487–8 ; ii., 614 ; 1903, i., 213 ; *Agri. Ledg.*, 1901, No. 10, 365-6 ; Dunstan, *Imp. Inst. Tech. Repts.*, 1903, 234.]

D.E.P., iv., 597-602. Henna.

LAWSONIA ALBA, ***Lam.*** *: Fl. Br. Ind.*, ii., 573 ; Talbot, *List. Trees, etc.*, 1902, 175 ; Gamble, *Man. Ind. Timbs.*, 371 ; Cooke, *Fl. Pres. Bomb.*, 1903, i., 511 ; Duthie, *Fl. Upper Gang. Plain*, 1903, 352 ; Prain, *Beng. Pl.*, 1903, i., 502 ; LYTHRACEÆ. The Henna Plant, *camphire, mehndí, shudí, manghati, maríthondí, henne, dan*, etc. A deciduous shrub wild in Baluchistan and on the Coromandel coast ; doubtfully so in Central India and the Deccan.

Cultivation.

Cultivated throughout India on account of its LEAVES, which yield the " henna," dye and also as a garden hedge plant. The soil is repeatedly ploughed and heavily manured, and the seed is soaked in water for twenty-five days before sowing, which takes place in April and May. The plot of land where the seeds are to be sown is formed into beds and kept flooded for some days. The seed is scattered on the water and sinks with it into the ground. For three days water is given both night and morning; after that only once a day till the plants appear above ground, when they are watered every alternate day. When about 2 feet high they are ready for transplanting in July and August. About 6 inches are nipped from the centre shoot, and the young plants are then put singly into holes one foot apart. They are watered daily till they have recovered the shock of transplanting, and the fields are weeded once a month. No crop is reaped the first year, but afterwards two crops a year are obtained, one in April–May, the other in October–November, for many years on end. At each cutting about 9 inches are taken from the top shoots, and an acre yields about 20 maunds of dry leaves a year.

Transplanting.
Cropping.
Season.

The Dye is obtained from the leaves: these are dried, sifted, a little sarson oil added, then reduced to a powder. This powder may be purchased at all the cosmetic and dye shops in the larger towns of India, and may be seen in small sacks alongside of the imported aniline dyes. It is occasionally used in dyeing cloth, but its principal value in India is as an article of the toilet, for staining the finger-nails, hands and feet a dull orange colour, also for dyeing the hair into a bright red colour, what is often but a first stage in the production of black by the action of indigo on the original red. The use of *henna* as a cosmetic dates from very ancient times, and is universal among Muhammadan women, and to a greater or lesser extent among Hindus also. The seeds yield an Oil about which little is known, and the flowers are employed in perfumery and embalming. [*Cf. Pharmacog. Ind.*, 1891, ii, 41–4; *Gaz. Shahpur Dist. Pb.*, 1897, 172–3; Woodrow, *Gard. in Ind.*, 1899, 319; Firminger, *Man. Gard. Ind.* (ed Cameron), 1904, 565.]

Dye.
Cosmetic.
Oil.

LEAD and its Salts and Manufactures. Ball, *Man. Econ. Geol. Ind.*, 1881, iii., 281–311; King and Pope, *Gold, Copper, Lead in Chota Nagpur*, 1891, 95–9, 156, 159–69; *Rec. Geol. Surv. Ind.*, 1904, xxxi., pt. 1, 46–7; Holland, *Rev. Min. Prod. Ind.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. 1, 110. This metal bears among other names the following:—*sísa, búndí, surb, ikam, temaëtam, khai-pok*, etc. It rarely occurs anywhere in the native state, and is never found in that condition in India. Its commonest ore is the Sulphide or Galena, *surmá, anjana.* Other common ores and salts are:—Red Oxide of Lead, *sandhur, segapú, temaméra, h'sang*, etc.; Litharge, *murdasang, marudar singhie;* Carbonate of Lead, *saféda, vullay, sibaydú*, etc.; Chromate of Lead, *peori-wilayti* (= English *peori*, see p. 765).

D.E.P.,
iv., 602–5.
Lead.

Mining.—Although lead ores have been worked to some extent in ancient times, at the present day lead-mining in India is practically in a dormant condition. Holland makes the following statement with regard to it:—"Galena alone, or with blende and other sulphide ores, is known in various parts of India and Burma, and has been worked in various places for lead or lead and silver, under past Native rulers; but the mining of lead-ores has long been extinct, and the only recent attempt calling for special mention is that now being made to develop the deposits near Pang Yung in the Northern Shan States formerly worked by the Chinese, who left behind large heaps of slag reported to be amenable to profitable treatment by modern metallurgical processes for the extraction of silver."

Mining.

Manufactures.—The metal is comparatively little employed by the Natives of India, owing to its scarceness. It is, however, occasionally used in the manufacture of certain wares and alloys, as for example in Hyderabad and Lucknow, where it is a component of the alloy of which *Bidri* ware is made (Watt, *Ind. Art at Delhi*, 1903, 47). Both the red oxide of lead and the carbonate or white lead are commonly utilised as pigments, *e.g.* in lac turnery (Watt, *l.c.* 211–2, 231), in Afridi waxcloth (*Agri. Ledg.*, 1901, No. 12, 400 *et seq.*). Red oxide is largely employed for religious purposes by the Hindus, who mark their idols and their money with it. All married Hindu women employ it as a paint to give a circular spot on the forehead. In Medicine, the monoxide or litharge, the carbonate, acetate, sub-acetate, nitrate and iodide are all officinal in the Indian Pharmacopœia. All these salts, except the acetate, are applied externally only, as sedative and cooling astringents, in various skin diseases. The acetate is similarly used, but is also administered internally.

Manufactures.
Uses.
Medicine.

Trade.—The Imports of lead from foreign countries are very considerable:

Imports.

Sheet Lead for Tea Chests.

in 1906–7, 102,455 cwt., valued at Rs. 15,82,550. In addition, Government imported 12,301 cwt., valued at Rs. 1,58,840. The greater part of these imports came from the United Kingdom. But it has to be pointed out that the chief market is the supply of the tea industry with the sheet lead required for lining tea chests, which is admitted free of duty. This came in 1905–6 to 82,166 cwt., valued at Rs. 11,23,738, and in 1906–7, 57,307 cwt., valued at Rs. 8,76,730, and was consigned from the United Kingdom almost entirely to Bengal. In the year 1906–7 the chief sources of supply for lead of all kinds were as follows :—United Kingdom, 76,230 cwt. ; Australia, 16,001 ; France, 4,139 ; Belgium, 2,090 ; Ceylon, 2,864. The share of the Presidencies and Provinces in the imports were : -Bengal, 72,548 cwt. ; Bombay, 10,772 ; Madras, 6,197 ; Sind, 4,918 ; Burma, 3,493.

Exports

The EXPORT trade in Indian merchandise is a negligible quantity, but a fair re-export trade exists. Thus in 1906–7 it amounted to 5,293 cwt., valued at Rs. 46,402. The bulk of this re-export traffic goes from Bombay, chiefly to the United Kingdom, Arabia, Persia and Turkey-in-Asia. [*Cf.* Tavernier, *Travels* (ed. Ball), 1889, ii., 281, 284 ; Masson, *Journ. to Kalat*, 1843, 462 ; *Minerals, Offic. Correspond. Rev. and Agri. Dept. Govt. Ind.* (*Proc.*), Dec. 1892 ; *Rev. Min. Prod. Ind.*, 1893, 11 ; 1894, 21-2 ; 1895, 46 ; 1896, 47 ; 1897, 46–7 ; Thorpe, *Dict. Appl. Chem.*, 1899, ii., 407–9, 411–35, 436–8, etc. ; Dutt, *Mat. Med. Hind.*, 1900, 72–5 ; Scott, *Gaz. Upper Burma and Shan States*, 1900, ii., pt. 1, 301–4 ; Rawson, Gardner and Laycock, *Dict. Dyes, Mordants, etc.*, 1901, 211–4 ; *Journ. Soc. Chem. Indust.*, 1904, xxiii., 338–9, 624–5, 935, 1000, 1162–3 ; 1905, xxiv., 28, 338, 487–8 ; 1906, xxv., 32.]

D.E.P., iv., 621–5. Lentil.

LENS ESCULENTA, ***Moench.*:** Duthie, *Fl. Upper Gang. Plain*, 1903, 257 ; Prain, *Beng. Pl.*, 1903, i., 367 ; *Ervum Lens, Duthie & Fuller, Field and Garden Crops*, 1883, ii., 13, t. xxx. ; *Fl. Br. Ind.*, ii., 179 ; LEGUMINOSÆ. The Lentil, *masúr, channangi, mohr, chanching, kerze, adah, misurpurpur, misur-pappu*, etc. A valuable pulse, grown as a winter crop all over India. According to De Candolle, it is a native of western temperate Asia, Greece and Italy, and has long been cultivated in Egypt, whence it was conveyed to India. As an article of food it has been known from the most ancient times.

Cultivation.

Cultivation.—At the present day the lentil is cultivated in all parts of India, especially in the Central Provinces, Madras and United Provinces. The following is a brief summary of the area under cultivation and the methods pursued in those provinces about which trustworthy information can be obtained.

Bengal.

Seasons.

Cost.

Bengal. Separate returns for this pulse are not recorded, hence an estimate of the area under cultivation cannot be given. It thrives best on a clay soil, since in light soils the plants wither away. In rotation following paddy (rice), the land receives three or four ploughings and the seed of the lentil is then sown October to December at the rate of about 5 seers per *bigha* (= one-third acre). In some parts of the country it is mixed with barley. Harvesting takes place from the middle of February to the middle of April; the crop yields about 8 maunds per acre. The cost of cultivation has been estimated at Rs. 2–10 per acre. [*Cf.* Basu, *Agri. Lohardaga*, 1890, pt. ii., 34; Banerjei, *Agri. Cuttack*, 1893, 83.]

Assam.

Crop.

Assam.—Cultivation is chiefly confined to the *chaparis* of Kamrup, Nowgong and Mangaldai. In Upper Assam it is cultivated to a small extent in the Majuli. The crop prefers a light, loamy soil and an open situation, and generally follows a broadcasted *áhu* (rice) crop, and is sown in mixture with mustard. Sowing takes place within the first fortnight of November. The seed rate is 12 lb. per acre, if sown with mustard, but if sown alone, about 50 per cent. more seed is required. Harvesting takes place in March and April, and the usual yield is about 2 to 4 maunds per acre. [*Cf. Agri. Dept. Assam Bull.*, 1902, No. 9, 11.]

U. Prov.

Area.

United Provinces.—The area under *masúr* is not separately recorded, but in 1904–5 peas and *masúr* together occupied an area of 2,055,879 acres, distributed thus :—1,437,152 acres in Agra, 618,727 acres in Oudh. According

Location. **Yield.**

to Duthie and Fuller, cultivation is most extensive in the damper parts of these provinces. It is sown in all kinds of soil, but chiefly in low-lying land. Generally it follows early rice, being often sown while the rice stalks are standing, and is allowed to grow up amongst them. The seed rate varies with the condition of the ground, but is commonly about one maund per acre. The outturn from unirrigated land varies from 6½ to 8 maunds per acre, but with irrigation may reach 10 to 12 maunds.

C. Prov. **Area.**

Central Provinces and Berar.—In 1904–5 the area under the crop was in the Central Provinces, 231,756 acres, chiefly in the Chhattisgarh, Jabbalpur and Nerbudda Divisions, and in Berar, 13,167 acres. It is generally sown on the best black soil.

Panjáb. **Inundation Crop.** **Seed.**

Panjáb.—No statistics of area are available. In the Jhang district, which is typical of the province as a whole, it is a *sailaba* or inundation crop. New alluvial soils or light lands, not good enough for wheat, are selected. The land is ploughed once or twice and the seed is sown broadcast, 30 to 45 lb. per acre, from December to January. The crop is ripe in March to April. [*Cf. Gaz. Panjáb Dist.*]

Bombay. **Area.** **Soils.** **Season.**

Bombay.—In 1904–5 the area was 9,791 acres, chiefly in Násik (5,097 acres) and Belgaum (2,918 acres). *Masúr* is always an unirrigated *rabi* crop, and generally is grown alone. In Poona it is the sole crop of the year, and is rotated with dry-crop wheat. The soil is mixed black, but only of moderate depth. In September and Octboer the land is repeatedly ploughed, and in October the seed is drilled in rows a foot apart at the rate of 20 to 25 lb. per acre. The crop ripens in three and a half months, and a good outturn is about 300 lb. per acre. [*Cf.* Mollison, *Textbook Ind. Agri.*, 1901, iii., 89–90.]

Food. *Dál.* **Vegetable.** **Ervalenta.** **Medicine.**

Food.—In India it is eaten as *dál*, flavoured with various aromatics and condiments, also as a component part of the dish called *kichri*, and is considered the most nutritious of the pulses. The young pod is also eaten as a vegetable, and the dry leaves and stalks are greatly prized as fodder. In Europe this pulse meal, mixed with barley flour or other cereal and common salt, is sold as an invalid food under the name ERVALENTA or REVALENTA. Leather (*Ind. Food-Grains and Fodders, Agri. Ledg.*, 1901, No. 10, 366) gives the following CHEMICAL analysis:—moisture 8·03 per cent., oil 1·06, albuminoids 23·0, soluble carbohydrates 61·14, woody fibre 2·42, soluble mineral matter 3·54, sand and silica 0·81, total nitrogen 3·94, albuminoid nitrogen 3·68. As a MEDICINE, lentils have long had the reputation of being useful in cases of constipation and other intestinal affections.

[*Cf.* Bentham, *Rev. of Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 139; De Candolle, *Orig. Cult. Plants*, 1884, 321; Church, *Food-Grains of Ind.*, 1886, 138–9; Asa Gray, *Scient. Papers*, 1889, i., 347; Kanny Lall Dey, *Indig. Drugs. of Ind.*, 1896, 174–5; *Yearbook of Pharmacy*, 1898, 77.]

D.E.P., ii., 142–52; v., 185–6. **Lime.**

LIME, MARBLE, CHALK, etc., or Calcium and its Salts and Manufactures.—Although *Lime* (Calcium) does not exist in a pure state, in the form of the carbonate it constitutes a by no means insignificant portion of the earth's crust, *e.g.* limestone rocks. *Lime-burning* is the operation of driving off carbonic acid from the carbonate with the production of the oxide of calcium or *Quicklime*. This readily absorbs water and becomes *Slaked Lime* or hydrate of lime (*Agri. Ledg.*, 1902, No. 5, 137–47). The subject may, therefore, be dealt with under two great sections—**Calcium Carbonate** and **Calcium Sulphate.**

Indian Names.

LIME, CARBONATE OF.—This is known in India by an extensive series of vernacular names that denote the conditions (quicklime, slaked lime, etc.) and the sources (limestone, marble, chalk, shells, etc.). The most general name is perhaps the Hindustani *chuná*, a word which in the various languages of India assumes numerous forms, such as *chúnáh, chún, chúno, chúnak, chúnámbu, chúrna, shunnambu, sunnam,* *sunna*, *hunna*, *hunu*, etc. Its most general name in Sanskrit would appear to be *sankha-bhasma*, but certain writers give also *chúrná* (= a "powder"), *sudha*, *kapardaka-bhasma*, *sukti-bhasma*, etc. Its Arabic names appear to be *kils* and *ahu* and its Persian *nurkah* and *ahak*. CHALK is very generally known as *khari-matti* or *kharya-mitti*. UNSLAKED or QUICKLIME is *kali-ka-chuna* or simply *kali* or *kalai*, often also called *ahak*; LIMESTONE is *kalai-ka-pattar*; SHELL LIME is *sipi-ka-chuna*; the lime from LIMESTONE LIME being *kattal-ka-chuna*; MARBLE is *marmar*; FOSSIL CORALS are *sang-i-yahada*.

Chúnám.

The word *chúnám*, by modern usage, generally denotes, however, the beautiful plaster or cement characteristic of many localities of India, more especially in the south (see below in the paragraph devoted to **Mortar and Cements**, p. 713). One of the earliest European writers to use the word *chúna* appears to be Garcia de Orta (A.D. 1563), although fifty years previously the Italian traveller Varthéma describes the people around Calicut as eating betel leaves along with a certain lime made from oyster shells, which they call "*cionama*.'

Sources.—There may, in India, be said to be three great groups of rocks or materials that afford lime, as follows:—

Limestones.

Indian Supplies.

Porbandar.

Trichinopoly.

Palnad.

Wardha.

Katni.

Mirzapur.

Lakhimpur.

Khasia.

(*a*) *Limestone, Dolomite, Miliolite, etc.* (*Imp. Gaz.*, iii, 148–50).—Hardly any known geological formation in India is wholly without limestone in some form, although many of the examples are exceedingly impure and scarcely worthy of the name. Mr. R. L. Sevenoakes, in the *Journal of the Queen Victoria Indian Memorial Fund* (No. 2, 26–31) (a publication here utilised freely), describes some twenty different kinds of Ornamental Building Stones. Some Indian ornamental stones are of nearly equal merit to the marbles specialised below, and still others gradually decline until they have to be characterised as at most only good building limestones. The limestones procurable in many parts of Bombay and Sind, for example, are admirable building stones, though marble nowhere exists in that Presidency. The Porbandar miliolite (foraminiferal limestones) has been conveyed from Kathiawar to Bombay and even to Calcutta, and is employed in the construction of some of the more important of the recent buildings of these cities. In South India it may be said that crystalline limestones occur in Trichinopoly and Coimbatore, but of very inferior quality; good building limestones are found in Cuddapah, Karnul and Guntur, and marbles at Palnad. In the Central Provinces there are numerous examples of limestones and admirable building stones, such as those of Wardha, Nagpur, of the Vindhyan formation, such as the limestones of Katni; and in the United Provinces the crystalline limestone of Mirzapur, which occurs in the metamorphic rocks of that district. In various localities of the Panjáb good limestones and even marbles are found. Lastly a reference is essential to the limestones of Lakhimpur and of the Khasia and Jaintia hills of Assam.

Commercial Lime.

The most important sources of limestone and lime may thus be grouped commercially:—

Satna.

Sylhet.

"1. *SATNÁ* in Rewah and at Katní, in the Jabbalpur district. From both localities lime of excellent quality is carried as far as Calcutta (624 and 685 miles distant), and constitutes a large proportion of the lime used in that city. 2. *SYLHET.*—Along the southern foot of the Khasia and Jaintia hills there is an inexhaustible supply of nummulitic limestone, which formerly supplied the whole of the demand of Calcutta and Lower Bengal, Rhotasgarh.

Himalaya.

Andaman.

Local Supplies.

and still does so to a large extent. The returns of 1904 show a supply of 123,108 tons of lime, valued at £9,496. 3. *RHOTASGARH.*—The lower Vindhyan limestone near Rhotasgarh is quarried to a small extent, and exported down the Són in boats; it was largely used in the works of the Són Canal. Good lime is made from the deposits at Bisra, in the Singbhum district, and has recently begun to arrive in Calcutta in increasing quantity. 4. *HIMALAYA*—Along the foot of the Himalaya, boulders of limestone are collected and burnt in large quantities every year; the slaked lime is exported on camels and supplies a large portion of the Panjáb and the United Provinces. 5. *ANDAMAN*—There is a band of cream-coloured marble near Port Blair which may prove of economic importance, as it is about the same distance from Calcutta as Katni, and the lime is of equally good quality. 6. *OTHER LOCALITIES* where limestone is known are numerous, but at present of merely local importance, or in most cases of no value whatever. A full list of them as far as they are known will be found in the *Manual of the Geology of India* (1881, iii., 449 *et seq.*)."

Kankar.

(*b*) **Lime, Concretionary or Kankar;** *Imp. Gaz.*, *l.c.* 23.—Medlicott explained the formation of this substance as due to the evaporation of the ground water, containing in solution more or less of carbonate of lime, produced in the slow process of soil-formation by the general decomposition of rock particles. Its production is, however, very much a matter of climate, *i.e.* alternating periods of extreme moisture and dryness. In the vast majority of cases a layer of *kankar* (a word which means simply nodular stone) will be found to underlie *úsar* soils. This circumstance has been purposely only incidentally alluded to in the passages that deal with *réh* efflorescence (p. 52), because, although doubtless formed by the same physical processes, *réh* and lime have not been shown to be dependent on each other. *Réh* efflorescence may occur without any formation of *kankar,* and conversely *kankar* may exist within the soil without any evidence of *réh* efflorescence or even of an abnormal deposition of soluble alkalis.

Valuable Asset.

Road-making.

Mortar.

Kankar is the chief source of lime in Upper India, and it yields an excellent and somewhat hydraulic cement. Holland (*Rev. Min. Prod.*, *l.c.* 1898–1903, 102) speaks of *kankar* and laterite as "about the most valuable assets in building material possessed by the country." James Cleghorn (*Ind. and East. Engin.*, June 1898, 356–7) gives the results of his study of this substance and of its practical utilisation as mortar. Very often the nodules of *kankar* are so abundant, at certain depths below the surface of the ground, that they become consolidated into blocks. Such blocks when obtainable are largely employed for building purposes, and were so used extensively in the Ganges Canal Works. *Kankar*, broken and hammered while water is poured over, is the material mainly used for road-making in the greater part of India. This circumstance gives at once a vivid conception of the abundance and extensive distribution of the substance. *Kankar* has been tried as a flux for iron on several occasions, but with very indifferent results. Its composition is too variable and its liability to adulteration too great to admit of its use, except where limestones are not available. "Large quantities of lime are made in various parts of India from highly calcareous surface soil." "This lime when mixed with proper proportions of sand makes most excellent mortar." (*Rept. Chief Insp. of Mines in Ind.*, 1904, 4.)

Shell Lime.

Coral Reefs.

Portland Cement.

(*c*) ***Lime, Shell and Coral.***—All over India shells are burned for lime. Away in the interior of the country, wherever annual inundation occurs, a marvellous crop of exceptionally large land shells furnishes an abundant supply for most local necessities. In the Murshidabad district, for example, the following shells are so employed :—***Unio marginalis, U. flavidens*** and ***Ampullaria globosa.*** On the coast tracts of India and Burma, immense beds of marine shells and of raised coral reefs are met with (see p. 989). Holland (*l.c.* 1904, 21) says that "the returns of various districts in Burma show a production of 67,461 tons valued at £11,852." These deposits, wherever met with, are regularly utilised as sources of lime, and in South India have mainly given birth to the prosperous industry of Portland Cement manufacture—an industry that is likely to be very shortly organised near the mouth of the Ganges, where rich beds of marine shells are abundant, and may be used to supplement the Sylhet limestones. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1904–5, 32) observes that while the proportion of lime in limestone and *kankar* is variable that of shells preserves a uniform high average. A sample of stone-lime examined contained 55·3, while a specimen of shell-lime gave comparatively 96·9 calcium carbonate.

Industrial Uses.

Manure.

Resisting.

With Indigo.

Waxcloth.

Tanning.

Soap and Candles.

Iron-smelting.

Industrial Uses of Lime, Limestone and Marble.—Lime is universally present in the ash of all plants. As a manure, therefore, it plays an important part, especially for soils rich in organic matter. [*Cf. Trop. Agrist.*, 1906, xxvi., 70–5, 180–8.] It hastens decomposition of both animal and vegetable matter. In the form of chloride of lime (bleaching powder) it was at one time largely utilised as a disinfectant, but has been considerably displaced by more effectual and less objectionable substances such as carbolic acid. As a bleaching reagent chloride of lime is extensively employed, such, for example, as in the raising of metallic colours, in discharging Turkey reds, and in calico-printing, etc. In India lime is made into a resist paste with ordinary gum-arabic, and in that form is utilised by the calico-printer. Lime, in some form, is in fact very generally used in the dyeing and tanning industries. It is, for example, nearly universally employed by the Native manufacturers of indigo. [*Cf. Monographs, Dyes and Dyeing* :— *Assam*, 4 ; *U. Prov.*, 84 ; *Bombay*, 24, 30, 34, 37 ; *Madras*, 4.] Along with sugar it is added to the dyer's indigo vat in order to assist in the production of white indigo. Calcium carbonate is employed as an oil paint for indoor work, and as a water colour mixed with gelatine. The Afridi waxcloth workers (see **Carthamus,** p. 282) add lime to their *roghan* to reduce its liquid condition and make it dry readily. The tanner utilises it to remove the hair from hides. [*Cf. Monographs, Tanning and Working in Leather* :— *U. Prov.*, 7, 9 ; *Madras*, 12, 30–4 ; *Bombay*, 15 ; *Bengal*, 10–11 ; *C. Prov.*, 68.] Lime was formerly of the greatest importance to both the soap and the candle makers (in the saponification of the fats), though in Europe to-day they mostly purchase a prepared alkali. Lastly, limestone is necessary as a flux in iron-smelting. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 252 ; Alder Wright, *Oils, Fats, Waxes, etc.*]

Pán.

Defecation of Sugar.

Food and Medicine.—As an article of (what might be called) food, it is largely used by the people of India. In other words, it is an essential ingredient in the preparation known as *pán*. The lime obtained from shells is objected to, however, for that purpose, by certain Hindus, on the ground that it is derived from animals. It is used in the defecation of the saccharine juices (see pp. 929, 954). The coagulation of the nitrogenous matter by boiling is less perfectly accomplished in the case of beet than of cane juice. The addition of slaked lime accordingly greatly facilitates that result by the formation of insoluble lime compounds. For MEDICINAL purposes, lime enjoys a well-recognised position, more especially as the basis of the mild antacid known as "lime water." [*Cf.* Waring, *Baz. Med.*, 1897, 90-4; Barry, *Legal Med.*, 1902, 389, 451.]

Medicine.

D.E.P., ii., 245 **Cement.**

Mortar and Cements.—By far the most important use of lime is as mortar—a cement which consists of lime, sand and water (see pp. 292-3, 695). If lime be mixed with water, a paste is formed that will rapidly harden or "set," as it is called. When dry it will, however, be found to crack and crumble to pieces. To prevent this it is mixed with sand (or in India with the fine powder made from brick known as *surkhi*). To obviate a too rapid evaporation of water from the mortar, it is customary to moisten the stones or bricks, when a much more durable cement is the result. If mortar be properly prepared, a thin layer is found sufficient to bind together the materials with which it is mixed.

Sand and *Surkhi.*

Ancient Stucco.

Stein (*Ancient Khotan*, 1907) describes the stucco used in plastering the surfaces of walls made of wood, mud, and (sun-dried) bricks in buildings uncovered by him from the sand with which they had been engulfed during the 3rd to the 8th centuries. The stuccoed surfaces were found to have been frescoed very elaborately and beautifully, and in many cases statues made of mud were found to have been coated with stucco and subsequently painted. In a further paragraph reference will again be made to Stein's discoveries in connection with plaster of Paris (see p. 718). It would thus seem fairly certain that an advanced knowledge existed in Eastern Turkestan of certain uses of lime long before that material came into use as a cement in stone and brick construction. The oldest constructive buildings in India, such as the Chulikyan temples of the Deccan, have the stones so fitted into each other or are of such massive blocks that they have remained in their positions for centuries without cement of any kind having been used. It seems thus fairly certain that the use of cement in house-building was subsequent to the date of the temples named. [*Cf. Papers Relat. to Magnesia Cement, Mad. Govt.*, 1826-37; Butler, *Port. Cement*, 1899.]

Ancient Temples.

Classification.

There are commonly said to be the following classes of cements:—(*a*) calcareous; (*b*) gelatinous; (*c*) glutinous; (*d*) resinous; (*e*) mixed materials but non-resinous. The first mentioned are those with which the present article is more immediately concerned, such, for example, as the mortar already indicated. A hydraulic cement, or Portland cement as it is called, is in other words a cement which has the property of setting under water. This is obtainable from certain limestones that naturally contain from 10 to 25 per cent. of alumina, magnesia and silica, or may be artificially manufactured by mixing 65 to 80 parts of chalk or other pure lime with 20 to 35 parts of river mud or clay and a little oxide of iron, say 3 to 14 per cent. These ingredients are thoroughly mixed in water, dried slowly, calcined, and then reduced to a powder. In India, Portland cement is at present mainly manufactured in the Madras Presidency, and more recently works have been started in Bengal, but in other provinces it is occasionally prepared, and chiefly from argillaceous *kankar* to which a certain proportion of fat limestone is added. But it is a striking peculiarity of these hydraulic cements that

Hydraulic Portland.

Madras.

Stucco.

their adhesive power is diminished by mixture with sand. When used as a stucco the sand employed must be perfectly free from loam, and the surface must not be painted over (if that be so desired) until the cement has been thoroughly dry for some months.

White Mortar.

It may further be added that if Portland cements have more than 4 per cent. magnesia they rapidly decompose when kept under water. A cement with a basis of white magnesia in place of clay is sometimes known as "White Mortar." There are large deposits of magnesite and of magnesium limestones (dolomites), especially near Salem in South India, and these it is understood have recently been taken advantage of by the Madras Portland Cement Company in the preparation of a cheap, easily applied and rapidly drying plaster that takes a fine polish. In the public press it is not uncommon to read the certificates of "Arbuthnot's Portland Cement" as being "equal to the best-known brands of English Portland Cement." Mr. C. S. Middlemiss wrote in 1896 a most interesting report on the magnesite areas of the Chalk Hills near Salem (*Agri. Ledg.*, 1896, No. 15). Papers written by James Cleghorn (*Ind. and East. Engin.*, May 1894, 320-1; 1898, ii., 210-11; iii., 32-3; iv., 28, etc.) will also be found to contain much useful information regarding magnesian cements. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 132-42; *Min. Indust. in U.S.A.*, 1900, 75, 82; Gilmore, *Hydr. Cements*, 1-334, etc.]

Chunám.

Composition.

Whitewash.

Chúnám.—Incidental mention has already been made of the fact that an admirable polishing and exceedingly strong cement (sometimes spoken of as *chúnám*) is made in several parts of India. There are various methods of preparing this substance, but these all practically agree in the circumstance that some saccharine substance is combined with the lime as well as powdered marble, plaster of Paris or steatite. The sugar most commonly employed for this purpose is the *jaggery* obtained from the cocoanut palm. The milk of that palm is also mixed with lime in the preparation of a very superior whitewash. It is believed that the sugar promotes the solubility of the lime, thus allowing of a finer and more complete state of division.

Carved Cement.

A special art of some parts of India, as, for example, in Bikanir, consists in carving cemented surfaces into rich floral designs that may be subsequently gilded or painted. [*Cf. Ind. Art at Delhi*, 1903, 95-6.]

Glutinous Cements.

Rice.

Flour Gluten.

Resinous Lac.

Cutlers' Cement.

Cement Materials.—Lime or some of its salts (such as plaster of Paris) is largely employed in combination with glutinous and resinous materials in the formation of cements. The rice-water is in India commonly mixed with a certain percentage of pure lime in the preparation of a strong cement which is employed to join the various parts of musical instruments in place of glue. Instead of rice, the dough of fine flour may be kneaded in water until gluten only remains. To this should then be added a small quantity of pure lime. The cement thus prepared is largely used for all forms of woodwork, and has the special merit of resisting damp. It is generally known by the name *sújí*. Lac combined with borax forms a convenient cement to be used where exposure to water or moisture is unavoidable. Cutlers' cement consists of rosin, bees'-wax and brickdust and plaster of Paris, or simply rosin and plaster of Paris. Dr. Fleming, in his *Account of the Salt Range*, says the Natives use plaster of Paris, mixed with pure lime, to produce their finest qualities of shining marble-like *chúnám*. It is also largely employed as a whitewash.

Special Cements.

For the materials employed along with lime in the formation of special cements, the reader is referred above (pp. 292–3) and to the respective positions in this work of the articles there indicated.

Marble.

Rajputana.

C. Prov.

Lime.

Marble.—The best-known marbles are those of the Aravalli series, which include the quarries of Jodhpur (Makrána), of Tonkra in Kishengarh, of Kharwar in Ajmir, as well as of Raialo in Jaipur, all in Rajputana, and of Jabbalpur in the Central Provinces. Within a radius of eight miles around Makrana there are something like 100 quarries, but of these only 15 are at present worked. They vary in depth from 30 to 75 feet, and follow the vein. The marble is excavated by blasting, and is then cut into the required size by steel saws. It is hauled to the surface on wooden rollers, and by manual labour. The quality of the stone is generally better according to the depth it is worked, but owing to the crude appliances used for hoisting to the surface, deep mines are impossible. The dust and fragments produced during mining operations at Makrana are burnt into lime, and this quality is much appreciated for the finer kinds of plastering. [*Cf. Journ. Queen Vict. Ind. Mem. Fund,* March 1904, 19–25.]

White Marbles.

Yellow Marble.

Black.

Mottled.

Grey and Pink.

Onyx-marble.

Coarse Grain.

Burma.

Colours.—The white marbles of Raialo are highly valued for filagree screens (*jálí*), of which numerous fine examples exist at Abu, Agra, Ahmedabad, Delhi, etc. The yellow marble of Jaisalmir (*khattu*) is a pure yellow, not white and yellow veined. It is used in the tomb of Ghayas Beg and his wife at Agra, and is so abundant as to be locally worked up as an ordinary building stone. The black marble found at Bainslana is carved into statues and toys. The black material in the inlaid work of the Taj and other Mughal buildings is a calcareous shale found in the lower Vindhyan series at Chitor. The handsome, mottled, green marble of Motipura in Baroda State, as also the grey and pink marbles of Narwár in Kishengarh State, are much admired and largely used for ornamental purposes. The onyx-marble of Nurpur and Shahpur, Panjáb, is famous. This is a cream-coloured rock streaked cloud-like with purple, hence its name *badal* (cloud). An exquisitely beautiful variety of onyx-marble is found near Jhuli in Baluchistan, too remote from civilisation to admit of its utilisation. The marbles and limes of Narnaul in Patiala State are also well known. [*Cf. Rec. Geol. Surv. Ind.*, 1906, xxxiii., 59–60.] It is commonly believed that the reason why the marble used in the Taj and other buildings has remained for three hundred years without getting tarnished is due to its coarseness of grain and chemical purity. A coarsely crystalline dolomite marble occurs near Mirganj, 11 miles west of Jabbalpur, but it includes numerous crystals of tremolite, and its use for tombstones at Jabbalpur shows that it is of inferior quality as a marble stone when exposed to the weather. In Burma the beautiful semi-transparent white marble so extensively employed for the figures of Gautama is obtained chiefly from the Tsygen hills in the Madeya Sub-division of the Mandalay district and near Sagaing.

Uses of Marble.

Uses.—Marble is thus in extensive demand for the decoration of sumptuous dwelling-houses, palaces, temples and mosques, and in the construction of idols, ornaments, toys, etc. A highly instructive account of its uses in the buildings of Agra will be found in the (*Agra Gazetteer* 1884, vii., 684-716, 728–35). In the *Ain-i-Akbari* mention is made

Inlaying.

Mughal Art.

Screens (*Jalí*.

of the skill of the Indian stone-carvers, but not of the art of stone inlaying. Both arts were, however, greatly improved during the time of Akbar's son and grandson. The use of marble became, in fact, the dominant feature of the new school of architecture that assumed such stupendous proportions with the Mughal rulers of India. Perhaps one of the most pleasing and at the same time surprising features of that great school of Indian architecture might be said to be the marvellous filigree screens (*jalí* work), in sandstone or marble, that take the place of the glass windows of European buildings. Keene (*Stone Indust. of Agra*) gives a very accurate and impressive account of the screens at Fatehpur Sikri (constructed 1581 A.D.). "The outer screens," he says, "are so minutely pierced that they actually look like lace at a distance, and illuminate the mortuary chamber with a solemn half-light which resembles nothing else that I have seen." In Agra a fairly extensive industry exists in the preparation of screens, tables, fancy boxes, picture frames, plates, vases, etc., as also models of the Taj and other ancient monuments. These are mostly done in white marble, inlaid with agate, carbuncle, carnelian, chalcedony, jade, jasper, lapis-lazuli, topaz, turquoise, bloodstones, garnets, rubies, sapphires, etc. This art is supposed to have sprung into perfection with the tomb of Itmad-u-Daula and the Taj (A.D. 1627–1658), and to have almost immediately thereafter gradually declined until at the beginning of the 19th century it had practically disappeared. It is said to have been revived by Dr. J. Murray about fifty years later. It has flourished ever since, the goods produced in Agra being carried for sale by the traders in Indian art wares all over India.

Fancy Work.

[*Cf. Marble in Architecture and Art*:—Birdwood, *Ind. Art. Ind.*, 1880, ii., 209–19; *Journ. Ind. Art and Indust.*, 1885, i., 61; Mukharji, *Art Manuf. Ind.*, 1888, 35–9, 48–50, 265–6; Lane-Poole, *Saracenic Art*, 1886, 47–122; Kipling, *Journ. Ind. Art and Indust.*, 1888, ii., 62; *Indust. Arts* (pub. by Council of Education), 1888, 211–20; Maurice Mandson, *L'Art Indien*, 1898, 32–50, 97–119; Watt, *Ind. Art at Delhi*, 1903, 64–8, 71–9; Hankin, *Journ. Soc. Arts*, 1904–5, liii., 461–77.]

D.E.P.,
iv., 195–7.
Gypsum

LIME SULPHATE: GYPSUM, Plaster of Paris.—This is the hydrous calcium sulphate generally known as GYPSUM; when in a fine grained condition, ALABASTER; and when in transparent crystals, SELENITE. On being calcined it parts with some of its water and then constitutes PLASTER OF PARIS. The powder thus produced on the addition of water gradually sets, and as it does so expands slightly. It is this property that has made plaster of Paris so exceedingly valuable for making casts and moulds. In India sulphate of lime is known by an extensive series of names such as *kulnar*, *kurpúra-silasit*, *kársi*, *sang-i-jeráhat*, *surma safed*, *makol*, *jirah*, etc. Plaster of Paris is generally known as *gach*.

Occurrence.
Madras.

Kach.
Sind.
Baluchistan.

Occurrence.—In the Madras Presidency it has been met with abundantly, but in an impure form, in the cretaceous rocks of Trichinopoly. Masses of gypsum and crystals of selenite are occasionally found in the clays of Chingleput. In Nellore, crystals of greater purity than those found near Madras have been recorded as fairly prevalent. In Bombay, selenite occurs in the marine deposits near the city, also in Kathiawar and in some parts of the Deccan. Very excellent gypsum is found in Kach. In Sind, deposits frequently 3 to 4 feet thick occur near the top of the Gaj beds of the Kirthar range. The Mud Gorge, on the Harnai route to Quetta, owes its intractable character to the circumstance that much sulphate of lime is there present, and very largely in the anhydrite condition. This absorbs water and thereby expands 33 per cent. The adjacent materials are in consequence continuously displaced, and the Mud Gorge may, therefore, be said to be in a state of constant change.

Rajputana.

In Rajputana, at Nagor in Jodhpur, a bed of gypsum probably not less than 5 feet thick has been worked to some extent. A similar occurrence is worked at Jamsar in Bikanir State. While excavating a well at Falod, gypsum of a very pure kind was found, but at too great a depth to be of much value. In the Panjáb (Bannu district) the mineral occurs in Kalabagh and in Khasor, but is not utilised. The Kohat district contains gypsum in great abundance. Ball says "it might be obtained by open quarrying in any quantity, but is not worked." The Salt Range possesses gypsum in enormous quantity, associated with rock salt. The Spiti Valley has gypsum of a snowy whiteness. In the United Provinces deposits of gypsum have been reported as met with in Dehra Dun, Kumaon, and Garhwal. Middlemiss (*Rec. Geol. Surv. Ind.*, 1889, xxii., pt. 2) gives a full account of the gypsum of Nehal Nuddi in Kumaon. [*Cf.* Hayden, *Mem. Geol. Surv. Ind.*, xxxvi., pt. 1, pl. 16.] *The Pioneer* (July 27, 1888) announced that gypsum had been found at a locality some 19 miles distant from Haldwani, a station on the Rohilkhand and Kumaon Railway. In Burma gypsum has been found, but not in sufficient quantity to be of much commercial importance.

Panjáb.

U. Prov.

Burma.

Industrial Uses.

Manure.

Industrial and Agricultural Uses.—For a great many years gypsum has been regarded as a manure of exceptional merit, especially for leguminous crops and for certain soils. It has recently been found to vastly increase the yield of indigo, so that a large demand seems likely to arise for it. The reader should consult the observations already made (p. 53) regarding the use of this salt as a neutralising agent, or rather one which so modifies the physical conditions of the soil as to bring it into a culturable state. Of manures that contain gypsum mention may be made of "superphosphate," which is a mixture of calcium sulphate with an acid phosphate of lime—the essential manurial constituent. It is prepared by the treatment of phosphatic minerals with sulphuric acid (Mukerji, *Handbook Ind. Agri.*, 1901, 569-71).

Sind Lattices.

Rajputana Stained Windows.

The next most important use for gypsum is the numerous methods of utilising plaster of Paris. In 1852 Dr. Buist drew attention to the interesting fact that the Natives of Sind had, from ancient times, been in the habit of casting lattices and openwork screens to be used within houses to allow of free circulation of air. The Marwaris very cleverly make what might be called stained-glass windows by taking two lattice screens, made of plaster of Paris, of identical pattern, and placing between these fragments of coloured glass so arranged as to bring out the desired colour in design. The screens are then firmly fastened together and the pieces of glass secured in their positions by a thin layer of liquid plaster being run over the lattice upon which the glasses have been arranged before pressing home (on the top) the second layer of lattice. In many parts of Rajputana and of the Panjáb the walls and ceilings of palaces are richly ornamented, in arabesque design, with glass. These are silvered behind or backed with plated metal discs or with coloured tinfoil, or they are painted on the surface and embedded singly or collectively in wooden frames, within a plaster, which consists mainly, if not entirely, of plaster of Paris. This work might be described

Shish-mosaics.

as a kind of mosaic, and from the fact of pieces of glass (*shishah*) being used, has come to be spoken of as *shish*-mosaic. The famous *Shish-mahal* (the Palace of Glass) at Agra, the *Shish-mahal* at Lahore, and the *Shish-mahal* in the ruined city of Amber (near Jaipur) are perhaps the best examples of this class of work. Mr. L. Kipling very truly says, " The effect of the *shish* or mirror mosaic, though brilliant, narrowly escapes the charge of vulgarity," so that it is not much to be regretted that the art may be said to be hardly practised at the present day. [*Cf.* Plaster of Paris work in *Ind. Art at Delhi*, 1903, 95–6.]

Casting and Moulding.

Ancient Khotan.

Krishnagar Modellers.

While it would thus seem that certain uses of plaster of Paris have been well known to the Natives of India for a considerable period at all events, a knowledge in the art of casting figures, ornaments and toys in that material is of comparatively recent date, and originated with the modern Schools of Art. While that is so, it is surprising to learn from Stein (*Ancient Khotan*, 244, etc.) that the whole of the stucco work discovered by him consisted very largely of plaster of Paris. Moreover, he tells us that the figures, idols, etc., had in many instances been moulded and elaborations accomplished in the form of extra figures, etc., by a process of *appliqué*. Grooves had been made on the plaster background to allow of the attachment of these extra mouldings, which were finally fused into their positions by liquid plaster. Since plaster of Paris moulding is quite modern in India proper, the ancient people of Khotan must have either discovered that art spontaneously or learned of it through their dealings with other than Indian races (see p. 713). So late as 1885, while engaged supervising the preparation of life-sized statues or models of ethnological subjects that were required for the Colonial and Indian Exhibition, I experienced the greatest possible difficulty in inducing the Krishnagar modellers to substitute plaster of Paris for clay. I procured a supply of gypsum from the Salt Range, had it fired in Calcutta, and found that it yielded a most excellent modelling plaster, and at a cheaper rate than I could purchase the imported article, which alone had been previously procurable in Calcutta. But my clay-modellers struck work, and I had to import others from Lucknow, and thus successfully threaten them with dismissal, before I could induce the Krishnagar men to resume operations. I mention this circumstance as showing the quality of the Indian plaster of Paris and its recent use in castings.

Alabaster.

Alabaster, where met with, is largely utilised in the manufacture of ornaments and toys. The dark-green form procured from Garhwal is regularly made into elegant cups and saucers and even large bowls that are much admired by the richer Native gentlemen of Northern India. The same material, drawn from various sources, is to some extent utilised by the stone-carvers in Agra and other centres of that industry. [*Cf.* Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 131–2.]

Trade.

Marble.

TRADE IN LIME, MARBLE, ETC.—With a country that possesses so many rich deposits of lime and marble, it is surprising to read of the large foreign imports that regularly take place. In the Calcutta press may be seen, almost daily, advertisements of dealers prepared to supply the " Best Italian Carrara Marbles " and " Best Belgian Jet Black Marbles " (*Journ. Soc. Arts*, 1901). So again, it is not uncommon to find mention of the coloured marbles of Montarrenti, Montalcino and Caldana, which are unrivalled in Italy for the beauty of their tints. It is well to remember that many of the columns, altars and floors of the Tuscan cathedrals, which are the admiration of the world, were constructed of these marbles. Mention is also frequently made in the Indian press of the Greek marbles, especially those of the Pentilikon quarries near Athens, and from the famous quarries in Thessaly, from which the genuine "Verde Antico" marbles were obtained. Many of the marbles met with in Indian household ornamentation have been derived from European quarries.

Imports. **Stone.** **Marble.** **Lime.** **Exports.** **Cements.** **Internal Traffic.**

The official returns of foreign trade adopt two headings, under which lime, marble, etc., are included. These are "Stone and Marble," and "Building Materials," such as "Cement" and "Chalk" and "Lime." The IMPORTS of Stone and Marble have ranged from 204,205 to 362,554 cwt. during the five years 1902–7, or a valuation of from 2¾ to 4½ lakhs of rupees. The chief item in point of bulk is stone from Arabia and Mauritius, used for road-making in Calcutta; and in point of value, marble from Italy to the extent of an average of 2½ lakhs of rupees for each of the years named. Turning now to the Chalk and Lime. The quantity imported is annually about 30,000 to 50,000 cwt., valued at about Rs. 30,000 to 36,000, and comes almost exclusively from the United Kingdom and is received mainly by Bengal. The EXPORTS from India have never exceeded 53,000 cwt., or a valuation of just under one lakh of rupees. These consignments go mostly from Madras to Ceylon. Of the Cements a very different story has to be told. The totals (during 1902–7) have ranged from 646,356 cwt. in 1902–3 to 1,788,428 in 1905–6, valued at from 13¼ to 32 lakhs of rupees. In 1906–7 the imports were 1,714,506 cwt., valued at Rs. 30,87,484. Fully three-quarters of the supply comes from the United Kingdom, and the balance mainly from Belgium, France and Germany. Bengal takes very nearly half the imports: the remainder goes to Bombay, Burma, Madras and Sind in the order named. Of the internal traffic in Stone and Lime very little can be learned. The rail and riverborne returns of minerals show a steady progression from an import of 6,733,264 cwt. in 1902–3 to 12,744,352 cwt. in 1905–6, with 12,149,239 cwt. in 1906–7. Taking the last year the chief receiving centres for Marble and Stone were:—Madras Ports, 3,443,282 cwt. (chiefly from Madras Presidency); Calcutta, 2,040,834 cwt. (from Bengal); and the United Provinces, 569,874 cwt. (from Rajputana and Central India). Chalk and Lime:—Calcutta, 1,606,523 cwt. (from Assam, Eastern Bengal, Rajputana and Central India, Central Provinces and Calcutta); and the United Provinces, 244,421 cwt. (from the Central Provinces and Nizam's Territory). Lastly, Others—a total of 66,986 cwt. Thus Assam and Madras are the chief sources of the lime traded in over India, but Bombay and Burma seem to be entirely self-supporting, as there are practically no records of interchanges from or to these provinces.

D.E.P., v., 2-77. Linseed and Flax.

LINUM USITATISSIMUM, *Linn.*, *Sp. Pl.*, 1st ed., 1753, 277; Mathiolus, *New Kreutterb.*, 1563, 130 with plate; also *Epitome* (ed., Camerarius), 1586, 200–1 with plate; also C. Bauhin, *Opera*, 1598, 333–4 with plates; Linschoten, *Voy. E. Ind.*, 1598, i., 80; Greaves, *Pyramidogr.*, 1646; Celsius, *Hierobotanicon, etc.*, 1747, ii., 283–312; Jones, *Select. Ind. Pl.*, in *As. Res.*, 1795, iv., 270–1; Sprengel, *Hist. Rei. Herb.*, 1808, 11; *Dict. des Sciences Nat.*, 1823, xxvi., 479-93; Billerbeck, *Fl.*

Classica, 1824, 85; Yates, *Text. Antiq.*, 1843, 252–91, 383–8; Daubeny, *Lect. Roman Husbandry*, 1857, 117–8; Bentham, *Rev. on Targioni-Tozzetti*, in *Journ. Hort. Soc.*, 1855, ix., 148; Royle, *Fibrous Pl. Ind.*, 1855, 135–232; Heer, *Die Pflanzen der Pfahlb.*, 1865, 35; also *Ueber den Flachs und die Flachskultur*, 1872; De Candolle, *Orig. Cult. Pl.*, 119–30; Liotard, *Cult. Flax Ind.*, *Select. Rec. Govt. of Ind.*, 1871–9, 1–36; *Fl. Br. Ind.*, i., 410; *The Wealth of Ind.*, 1897, 100–6; Hehn, *Kulturpfl. und Haust.*, 1894, 160–86; 570; Renouard, *Études sur le Culture du Linum.*; Voelcker, *Improv. Ind. Agri.*, 1893, 284–6; Watt, *Stat. Atlas Ind.*, 1895, 27; Dodge, *Flax Culture in Europe and America*, *U.S. Dept. Agri. Rept.*, 1898, No. 10; Mukerji, *Handbook Ind. Agri.*, 1901, 272–4; Mollison, *Textbook Ind. Agri.*, 1901, iii., 94–8; Wiesner, *Die Rohst. des Pflanzenr.*, 1903, ii., 276–99; Cooke, *Fl. Pres. Bomb.*, 1903, 154–5; Prain, *Beng. Pl.*, 1903, i., 288–9; Duthie and Fuller, *Field and Garden Crops*, ii., 40–2; Duthie, *Fl. Upper Gang. Plain*, 1903, 122–3; *Bull. Imp. Inst.* in *Board of Trade Journ. suppl.*, Dec. 1903, 188–200 (reviews papers pub. by *Dept. of Agri. and Tech. Instruct. in Ireland*, 1902, ii., 636 *et seq.*; 1903, iii., 663 *et seq.*); LINEÆ.

The above, out of the library of books that might be cited as dealing more or less fully with the subject of ***Linum*** (Linseed and Flax), may be consulted by the reader desirous of botanical, historical and industrial details. The names given to these products in Europe and Asia are so extensive and varied that only those of most frequent use can be here mentioned:—linseed, *linum*, *lein*, *lin*, *lino*, *linu*; flax, *vlas*, *flachs*, etc.; *alsi*, *alshi*, *alish*, *tisi*, *chikna*, *pesu*, *bijri*, *keun*, *zighir*, *javasa*, *atasí*, *alashi*, *masina*, *mushina*, *auma*, *ksumá*, *umá ziggar*, *kattan*, *zaghu*, *pischta*, etc., etc.

Perennial Flax.

Species and Races.—The Linseed and Flax Plant is cultivated throughout the plains of India, and up to altitudes of 6,000 feet above the sea. According to De Candolle (followed by most other botanical writers), it is indigenous to certain localities situate between the Persian Gulf and the Caspian and Black Seas. A consensus of opinion also favours belief that originally the perennial flax (***Linum angustifolium***) was the plant that in Europe was first cultivated for its fibre—a plant that is wild south of the Alps; and further that its displacement from popular favour took place about the close of the Stone Age of European history.

Plant first cultivated for Fibre.

There is no evidence of ***L. angustifolium*** ever having been met with in India either wild or cultivated. It would seem highly likely (as recently pointed out to me by Mr. J. R. Drummond) that the economic information recorded in the *Dictionary* under ***L. strictum*** may be incorrect —the plant intended to be denoted as cultivated in Afghanistan having very possibly been one of the numerous races of the ordinary linseed. That being so, the only truly wild ***Linum*** within the Indian area, at all related to the oil-yielding ***L. usitatissimum***, is ***L. perenne***, *Linn.*—a species found in Western Tibet at altitudes of 9,000 to 13,000 feet. This is reputed to have been occasionally seen under a crude cultivation, the seeds being valued on account of the oil they contain.

Indian Wild Plant.

Thus we are left completely in the dark, not only as to when and where the substitution of ***L. usitatissimum*** for ***L. angustifolium*** took place in Europe, but as to the origin of the stock that now affords the linseed of Indian commerce. According to some writers ***L. usitatissimum***, the modern flax-yielding plant of Europe, was derived from India.

Origin of Indian Stock.

Restrictions against the Fibre

Linseed Oil.

Atasi versus *Ksumá.*

History.—While the classic records of India certainly do make mention of *atási, umá, ksumá*, etc., etc., no account, either of the oil-seed or of the fibre, is such as to remove all possible doubt that linseed and flax were undoubtedly indicated, but it can be said that greater certainty prevails regarding the oil than the fibre. In the *Institutes of Manu* (bk. ii., 41) we read that the garments of students should consist of skins above and of fabrics of hemp, flax (*ksumá*) or wool below. So again (bk. v., 121), a man who knows the law is likened to purified linen cloth (*ksumá*). Lastly a Brahmin, if he be compelled to make his living as a trader (bk. x., 87), must not sell dyed cloth or garments of hemp, flax (*ksumá*) and wool. Thus there would seem no doubt that the word *ksumá* is of frequent occurrence, and that it denoted a fibre which was purified (bleached, doubtless). Kálidása speaks of the white colour of the cloth. But whether *ksumá* originally denoted linen or silk, or *rhea*, or ***Calotropis***, or some such fibre, but not necessarily linen, seems a doubtful question. Most commentators have, however, accepted the name *ksumá* as linen, and often with an atmosphere of such assurance as to convey the impression that there was no doubt, and could be no doubt, as to its determination. But if that view be correct it is, to say the least of it, curious that to-day the only use of the plant, known to the people of India, is as a source of linseed and linseed oil, not of fibre (*ksumá*) or garments of the same. In fact, it is the all but universal belief that the linseed plant will not yield fibre of sufficient merit to repay the expense of its separation and purification. Are we to suppose, then, that since classic times a complete revolution has in India taken place, and that cultivation as a source of oil-seed is comparatively modern—a consequence possibly of the Muhammadan conquests of India, if not of European commerce? Or is the other explanation more acceptable, namely that the passages above indicated refer to an entirely different plant (possibly cotton) or denote experience obtained and opinions held prior to the invasion of India, and, therefore, prior to any knowledge of the plant as a source of oil? Mr. F. W. Thomas (Librarian to the India Office) draws my attention to the fact that in *Susruta* (800 B.C.) *atasi* oil is spoken of as having a slight smell of flesh; of its being used like that of hemp and sesamum for poultices; and of its being pungent, light, penetrating and laxative. These are characters that would seem to denote linseed, so that the *atasi* of Sanskrit authors stands a better chance of having been linseed than the *umá* or *ksumá* of being flax. Dutt (*Mat. Med. Hind.*, 1900, 292) simply gives, in an appendix to his work, the name *atasi* as the Sanskrit of ***Linum***; *masina*, its Bengali; and *tisi*, its Hindustani; so that it may be inferred to have been a drug, in the opinion of the Sanskrit authors, that was unworthy of special consideration.

Linseed Oil.

Not mentioned by E.I.C.

The oil is occasionally mentioned, however, in the *Ain-i-Akbari* and in a few other such publications, but on the other hand all the early European travellers in India whose evidence is generally regarded as of value historically, are singularly silent regarding both linseed and flax. Rheede, Rumphius and Burmann make no mention of any species of ***Linum***. The East India Company's Records, as published by Birdwood and Foster (*First Letter Book*, 1600 to 1619), the subsequent six volumes of *Letters Received by The East India Company*, as also the still more recent work, *The English Factories in India*, 1618–21, prepared by Foster, do not contain any references to linseed or flax. Milburn (*Or. Comm.*, 1813), who deals with all the articles traded in between England and the East Indies, China and Japan of that date, makes not the slightest allusion to linseed or flax, though he deals with sesamum castor and other oils and oil-seeds as exported from India. Next to nothing of a historic character can, therefore, be recorded of the early production and trade in linseed. The only point at all conclusive is that the Muhammadans seem more closely connected with the origin of the traffic than the Hindus.

Buchanan-Hamilton's Account.

Carey's Account.

Buchanan-Hamilton (*Stat. Acc. Dinaj.* (written subsequent to 1807), 174) enumerates "Flax or Linseed, *mosina*" among his agricultural crops of Bengal, but makes no observations regarding it. Neither in his *Journey through Mysore, etc.*, 1807, nor in his *Account of the Kingdom of Nepal* (1819) does he refer to either flax or linseed. Ainslie (1826) says there was then a good deal of flax being cultivated in Upper India, especially in Bengal, for making oil; he then adds,—"of late years it has also become an object in the lower provinces." Carey (*As. Res.*, 1808, x., 15) was apparently one of the first authors who wrote definitely regarding Indian linseed. He says that the oil is mixed with mustard to such an extent that it is "unfit" for painting or the other useful purposes to which it is applied in Europe. Of flax he says the Natives know nothing of its use to make thread. In 1825 Thornton brought out the second edition of Milburn's *Oriental Commerce*, in which work it is stated that "flax is very generally cultivated in Bengal and Bihar for the oil which is obtained from the seeds, the stalks being rejected as useless." [*Cf.* Rawlinson, ***Hist. Ancient Egypt***, 1881, i., 62-3.]

Thus then from the observations already made, it may be inferred that the study of the production and utilisation of ***L. usitatissimum*** resolves itself into two sections, Flax and Linseed. These cannot of course be exhaustively dealt with, but I shall dispose of Flax (to India infinitely the lesser important product) first of all, and in a very few words.

Historic Experiments.

Proceedings Board of Revenue.

Arab Flax-dressers.

Roxburgh.

Cheap Binders.

Catch Crop.

FLAX AND LINEN.—The possibility of combining the production of linseed with the supply of flax has been spasmodically raised in India every now and again during the past hundred years or so. An important series of experiments and investigations were in consequence conducted in 1790 to 1810; another in 1840; and still a third in 1872, the object being not so much to ascertain whether a profitable combined seed and fibre industry could be organised, as to ascertain whether flax could become a commercial product of India at all. In the *Proceedings of the Honourable the East India Company*, preserved in the records of the Board of Revenue, Bengal, of date 1805-7, are many interesting details of the early experiments. Six Arab flax-dressers were sent from Bassora to Bengal, but failed to produce good fibre from the plants raised from the seed specially imported from Bassora. Roxburgh, in 1801, and again in 1806, gave accounts of the experiments he had conducted at the Company's Hemp Farm near Calcutta. An army of writers, down to Royle's time, may be said to have recorded their theories or narrated their experiments. On each occasion of special investigation, the results obtained were not deemed encouraging. But more recently still a new phase has arisen that may in the future assume some importance. The demand for cheap cordage, to be used as "binders," has suggested the possibility that the stems of the linseed-yielding plants (while they doubtless do not contain fibre of sufficient merit and abundance to justify being elaborately separated, cleaned, and placed on the market as Indian flax) may still by a simple method of preparation afford a cordage fibre that, as a catch crop, might undersell even jute. At present the stems of the linseed plant are not used in any way, and if they could be turned into a profitable by-product a great boon would doubtless be conferred on the Indian cultivators.

Reaping.

Are Both Crops Possible?

Vesque (*Traité de Bot. Agri. et Indust.*, 1885, 495) very properly observes that climate exercises a considerable influence on the qualities of fibre or seed produced. In warm countries the fibre is least abundant, but the seed crop profuse. He then adds that the seeds obtained from a fibre crop may be useful for oil, but they are imperfectly formed and can never be used for reproduction. Conversely, if the seeds be fully developed, the fibre is all but ruined. If the combination crop of flax and linseed be in India seriously contemplated in the future, the plants would have to be sickled close to the ground or pulled up by the root, the seeds being thrashed out and the stems subsequently treated for their fibre. But the question of all others that naturally arises is this—can the same plant yield both products profitably? Would it not be preferable to grow separate crops?

Official Investigations.

Extensive experiments would very possibly have to be conducted by the various Governments of India in order to ascertain the conditions

Features to be Tested.

necessary for a combination crop. It would have to be discovered whether a stock could be evolved a little richer in fibre than that presently grown, but which would still yield a fair crop of seed. The class of soils suited, the seasons of sowing, the methods of cultivation, and the period at which the harvest should be made, etc., etc., are some of the issues of importance that the Indian cultivators could not be trusted to investigate and solve for themselves. Then the methods and appliances required for separation of the fibre would have to be demonstrated, and above all, the final conclusion made abundantly clear, namely that the proposed departures from the time-honoured usages, in linseed cultivation, were in the *raiyats'* best interests, and that the vastly increased cost of seed to acre, the new expenditure in fibre-extracting appliances and the extra labour involved, could all be justified by the much greater returns obtained.

Unsuccessful Experiments.

Bengal.

Assam.

Machinery.

Baneful Influence.

In testing these and many other such aspects of the proposed new departure, the experience gained in the past (very nearly futile) experiments would have to be carefully borne in mind and the shortcomings guarded against. These results will be found in the *Dictionary* (v., 10–35) and it will be seen that the idea of utilising the fibre of the linseed plant is by no means new, but that several persons have unsuccessfully tried to obtain a useful fibre from it. For example, we read that some years ago the late Mr. Savi of Mohesgunge in Eastern Bengal found the stems of linseed too thin and woody to afford fibre. In Assam the Director of Agriculture, we are told, made some experiments in 1901 to ascertain if flax could be produced in that province. The plants grew well enough but were laid by heavy rain, and when taken up the fibre was found to be rotten. The following year better results were obtained, but the want of proper machinery, to separate the fibre, resulted in a report that denoted imperfect work rather than defective crop. In the report for 1904 it is stated that as the sowings had been made in spring, the crop had to ripen in July during the middle of the rains. It was accordingly contemplated to try an autumn sowing, notwithstanding the risk of frost. The report adds, "By sowing the crop in autumn it may grow and ripen in dry weather and escape the baneful influence of the monsoon rains."

Bihar.

Dundee Chamber of Commerce.

More Hopeful.

Risky Crop.

Recent Experiments.—It may now be stated that the Bihar Planters' Association have recently taken interest in the possibility of flax-growing being usefully resorted to by the indigo planters as a supplementary crop. At a meeting of the Dundee Chamber of Commerce (Sept. 20, 1904) this subject was alluded to with much interest, and a reference made to a committee having obtained an audience of His Majesty's Secretary of State, with the express object of urging this matter as specially worthy of the attention of the Government of India. The samples procured from Bihar were pronounced such as to suit a large portion of the trade. It would thus seem that within the past few years the question of flax-production alone, as well as of flax and linseed combined, have been once more engaging the attention of many persons, and it may be said that it will be a fortunate circumstance if a solution of the problem be at last found and a new and prosperous industry given to India, in continuation of the already long list of those that owe their existence or development to British commercial enterprise. It must never be forgotten, however, that linseed is at best a risky crop, and one that is resorted to by the *raiyat* for rent-paying purposes, but only when necessity occurs and favourable conditions are likely to prevail.

Recent Results. Average Yield. Good Fibre. Prices Realised. Profit.

Since the above was penned there has come to hand a report of the experiments recently conducted in Bihar, written by Bernard Coventry (*Agri. Journ. Ind.*, i., pt. iii., 192–200). It would appear that a few indigo concerns have experimented with flax during the past four years, and Coventry's remarks are apparently the result of experience gained. The following extract may be accepted as conveying the chief facts:—"There is as much fibre in the plant grown in India as at home, namely, about 20 per cent. of dried straw. The average yield of retted and dried straw at Dooriah from sowing at the rate of 2 maunds of seed, was 40 maunds per acre, and the percentage of fibre obtained from the straw was 15 per cent., or 6 maunds of fibre per acre. This should have given 4½ maunds of good fibre and 1½ maunds of tow, that is to say, the proportion of good fibre to tow should have been as three to one, but in point of fact it was only half good fibre and half tow." "The flax from the first year's experiments fetched £30 a ton, the second year £35, and this year it is expected to fetch £40 a ton, owing to its better quality. The price of tow was about £10 a ton. The cost of production, including cultivation, seed, manufacture, shipping, insurance, and other outlay expenditure, amounts to Rs. 62 per acre. Taking the 6 maunds of fibre to have sold at £25 a ton including tow, equal to say Rs. 13 per maund, we have a gross return of Rs. 78 per acre and a profit of Rs. 16."

Two Problems.

Coventry contends accordingly that the cultivation of the plant has been accomplished successfully, but concludes his report almost in the words used by Dr. Jameson in 1859, viz., "All that is required to market a useful crop in India are some good instructors to show how the fibre is to be prepared and fitted for the market, and good seed and machinery." Lastly, Coventry, like most other writers on this subject, adds, "There are two separate but closely connected problems for investigation: *first*, the possibility of establishing a new industry for the growth of flax as a fibre crop for the production of high-grade fibre alone; *second*, the possibility of introducing a system whereby fibre, probably of a lower quality, could be produced in combination with the existing large cultivation of linseed for oil-seeds." Students of this subject will find the information furnished by Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 73–7) highly instructive. They should also consult the recent results by Finlow (*Dept. E. Beng. and Assam*, 1906–7, app. ii.).

Paper Material.

Exhausting Crop. Food Value. Fodder.

It has been often urged that, even if the separation of a fibre should prove unremunerative, the stems might become of great value to the paper-maker. But the crop is well known to be an exhausting one, and on that account is often barred by many leases, hence an effort should be made to overcome these objections by improvements in manuring. Fowls are known to fatten very rapidly if allowed to stray over linseed fields, and a certain percentage of linseed-cake is the world over recognised as one of the very best food materials for prolonging and improving the milk of cows, especially when butter manufacture is an important consideration. It has, in fact, been remarked that along the foot of the lower North-West Himalaya, linseed is at times sown mainly as a cattle food for milch buffaloes—the oil being only a secondary consideration. In this connection, however, attention may be drawn to a brief note by Leather

Poisonous Property.

(*Cyanogenesis in Plants*, in *Agri. Journ. Ind.*, i., pt. iii., 225) on a poisonous property at times possessed by the linseed plant. He mentions a case where cattle ate some immature linseed as fodder with the result that fifty-two died in a few hours. A specimen of the plant sent for examination contained a cyanogenetic glucoside, and yielded prussic acid when crushed in water.

LINSEED AND LINSEED OIL.—The seed obtained from the cultivated *L. usitatissimum* is known as LINSEED, the oil expressed therefrom is LINSEED-OIL, and the cake LINSEED-CAKE.

Races.
Thin Sowing.
White and Red.
Grades.
Selection.
White-seeded Forms.
Condition not Constant.

The object being to promote flowering, not to produce long, straight, fibre-yielding stems, the seed is sown much thinner than is generally the case with European flax. The result of this special cultivation has been to develop several well-marked RACES, all of which possess one characteristic—a much-branched stem. There are two readily recognised kinds, namely a white-seeded and a red-seeded, and of each of these at least two grades with either "bold" or "small" forms of the seed. The latter may be only a condition of defective cultivation or immaturity of crop, but commercially the bold seed is the form of greatest value. The subject of the cultivated races of linseed is, however, too imperfectly understood to allow of more being at present said regarding them than that many distinct forms exist. It would, therefore, be the most obvious course to pursue, in any attempt at new developments of the linseed traffic, to improve the stock by careful selection in the direction desired, rather than to attempt the acclimatisation of exotic stocks. It is well known that the quality and yield of oil varies greatly in the seed of one country as compared with that of another. The white-seeded form has usually white coloured flowers, the brown-seeded blue flowers. Moreover, the white seed has a thinner shell, and contains nearly 2 per cent. more oil than is the case with the red. These facts have led to many inquiries as to the white-seeded plant being grown separately and the seed sent into the market pure. The demand for such pure seed has never, however, been so large and constant, nor the hopes of increased price sufficiently encouraging, to tempt producers to give the attention to the subject that would be necessary. Moreover, it is said that the quality indicated is not constant. In other words, under altered conditions, the white-seeded plant may produce red seed and thus frustrate the production of a pure crop. [*Cf.* Leather, *Effect of Change of Climate on Amount of Oil in Linseed*, in *Agri. Journ. Ind.*, 1906, i., pt. iv., 413–4.]

Area.
Mixed Cultivation.

Area under Linseed.—Very often linseed is grown as a mixed crop, being sown along with other oil-seeds and the two reaped together and used in the production of well-known blends of oils. At other times linseed constitutes lines through or borders to other crops, so that the greatest difficulty often prevails in determining the actual area under the crop. This is more especially the case in the United Provinces. But when grown mixed, the crop is all but universally intended for home markets, the crop grown for export being usually pure.

Drying Oil.
Mixed Oils.

To the Natives of India a drying oil is of no consequence since they do not require an oil with that property, hence the frequent admixture with mustard-oil seed, which greatly reduces the value of the produce from the standpoint of a drying oil. But such admixture is more often than not accidental, through produce being purchased that was not intended for the foreign market. Voelcker (*Improv. Ind. Agri.*, 1893, 285) discusses

Adulteration Standardised.

Purity not Demanded.

the adulteration or admixture of linseed and says that it is usually purchased in Bombay on a basis of 94 per cent. purity, and elsewhere on a basis of 96. It is, therefore, hardly to the interest of the shipper to get absolutely pure seed, since nothing more is paid for it in Europe than that adulterated to the extent named. Voelcker adds that an attempt was made some years ago to buy upon the basis of "absolute purity," but this proved a dead letter, since there was no demand in the home market for pure linseed.

Official Returns.

Chief Areas.

Unimpt. Areas.

During the past fifteen years the crop has fluctuated very greatly. Thus in 1891-2 it was 3,211,000 acres pure and 545,000 acres mixed; in 1895-6 it was 2,954,093 pure and 560,000 mixed; in 1899-1900, 1,648,903 pure and 409,000 mixed; in 1903-4, 3,609,079 pure and 592,000 mixed; in 1904-5, 3,747,400 pure and 647,000 mixed; in 1905-6, 2,700,400 pure and 567,000 mixed, while the *Final Memorandum* issued by the Commercial Intelligence Department estimates the area for 1906-7 as 3,028,200 pure and 633,000 mixed. Analysing the returns for the year 1905-6, by way of illustration of the distribution of production, we learn that Assam had 55,709; Eastern Bengal 103,000; Bengal 726,500; Agra 185,034; Oudh 60,880; Bombay 139,623; Central Provinces 812,068; Berar 96,703 acres, the balance on the total area being in Madras, Panjáb, Rajputana and Central India, and lastly Burma. The highest of all the unimportant areas is usually Madras, which in 1905-6 had 21,099 acres; and Sind the lowest, with 3 acres under the crop.

Production.

PRODUCTION.—It may now be useful to devote a few pages to a series of notes on the linseed of the chief areas of Indian production:—

Bengal.

Indigo Districts.

Ploughing.

Seed Rate.

Seed.

Yield of Oil.

Fodder.

1. ***BENGAL (including Eastern Bengal).***—As already indicated, Bengal, of all the provinces of India, has usually the largest extent of land under this crop, though in the year specially dealt with it had less than the Central Provinces. The districts of Bengal that had in 1905-6 the greatest acreage of linseed were Darbhanga, 138,500; Gaya, 80,000; Nadia, 49,000; Saran, 72,000; Champarun, 66,300; Muzaffarpur, 41,200; Jessore, 29,900; Murshidabad, 29,100; Bardwan, 22,500; Noakhali, 22,000; and Backerganj, 20,000 acres. It is thus a crop that may be spoken of as produced most abundantly within the indigo districts. At all events it is mainly grown, so far as Bengal is concerned, in Tirhut and Bihar. Mukerji (*Handbook Ind Agri.*, 272-4) says it is believed to love well-drained heavy, loamy soils, especially if rich in lime, such as those often under mustard or *til* crops. It requires more or less the same soil, in fact, as wheat and gram. The land should be prepared in September, and thorough and deep ploughing is desirable. Before the close of the monsoons the sowings are usually completed. The seed rate has been given as 8 to 12 lb. to the acre. If sown late, irrigation may be necessary, but when the plant is in flower rainfall is injurious. The crop is harvested by the end of February or the beginning of March and the seed extracted by flailing. Six to eight maunds of seed (say 500 to 700 lb.) is the average produce per acre. The straw is useless as fodder, and indeed it is even said that green plants eaten by cattle have been known to prove fatal. The seed is held to yield one-fourth of its weight of oil. The cake is regarded more valuable as food for milch cows than either *rai* or *tori* cakes, though the butter is said to be softer than that obtained where mustard- or cotton-seed cake has been given to the cows. Basu speaks of the straw of linseed being reduced to *bhusa* and given to cattle in mixtures with the *bhusa* of wheat, barley, gram, lentils, etc. It is considered as heating, and therefore seldom given to animals by itself. The crop is sometimes barren and thus becomes a dead loss to the cultivators.

Trade.

Price.

Trade in Bengal (see p. 728).—In the *Annual Report on the Maritime Trade of Bengal* (1904-5, 24) it is stated that "the quantity shipped rose by 26·7 per cent. and was the highest on record, the year 1898-9 coming next, but the value advanced by 6·6 per cent. only. In May, 1903, the price of linseed in Calcutta was Rs. 5 0-6 per maund; while in May, 1904, it was Rs. 3-10. The world's production in the year 1904 was enormous and in April the home price fell to 29*s*. per quarter, a figure not approached since July, 1896, when the price was 28*s*. 6*d*.

Shares of Exports.

The average price for 1904 was 33*s*. as compared with 39*s*. in 1903. There was an extremely large crop in Argentina, and the United Kingdom imported even more from that country than from British India. The United Kingdom took 55·5 per cent. of the quantity shipped from Calcutta, and Germany 33·7 per cent. Exports to the United States, which did not exist in the previous year, totalled 60,047 cwt." "In the United Provinces the outturn of pure linseed during the year was 26·3 per cent. better than the season before, and in Bengal the improvement was 5·7 per cent., or 41·4 per cent. above the ten years' average." [*Cf.* Basu, *Agri. Lohardaga*, 1890, pt. ii., 35 ; Banerjei, *Agri. Cuttack*, 1893, 89.]

C. Prov. and Berar.

2. ***CENTRAL PROVINCES AND BERAR.***—Judged of by the area devoted to the crop, these provinces are undoubtedly the second most important centres of production, and are usually just under the Bengal area. In 1905–6 the Central Provinces had 812,068 acres devoted to linseed and Berar had 96,703, or close on a million acres between them. A slight increase of these areas would have to be made to cover the mixed cultivations of linseed and wheat or linseed and gram, etc., which expressed as pure linseed usually represents a cultivation of say 30,000 acres. The districts enumerated in sequence of linseed acreage were in the *Central Provinces* :—Raipur, 181,699 ; Bilaspur, 109,993 ; Nagpur, 66,980 ; Wardha, 61,212 ; Bhandara, 68,950 ; Chanda, 82,533 ; Jabbalpur, 43,913 ; Balaghat, 28,358 ; Saugor, 23,970 ; and Damoh, 22,082. In *Berar* :—Wun, 46,129 ; Buldana, 19,563 ; Akola, 15,097 ; and Amraoti, 11,317. The balance in both instances on the total areas given is made up by districts with smaller acreages than those shown.

Chief Districts.

Outturn.

Sir J. B. Fuller, in a *Report on the Outturn of Crops* (1894, 20–2), furnishes many useful particulars regarding linseed. "Thirty years ago," he says, "the production of linseed was relatively very small. It is now one of the principal of agricultural resources of the Provinces, and crop statistics indicate that the area is still extending. But there is reason to believe that the land rapidly becomes linseed-sick, when it requires a long period of rotation." "By far the most important producing tracts are the Nagpur and Chattisgarh plains. In the former it is almost entirely a single crop. In the latter it is of most importance as an after crop, though its growth as a single crop is by no means insignificant." "The crop would be exceedingly profitable were it not very precarious. In a good year it gives a larger return than wheat with a far smaller outlay on seed and cultivation. But the plants are very sensitive to damp when in flower, and a few days' cloudy weather at this time will prevent the seed from setting and bring a promising crop to a disappointing harvest. Rust also causes great damage." The late Dr. Barclay (*Agri. Ledg.*, 1895, No. 20, 267–70, 351–2) devoted much attention to the study of that fungal parasite. While by no means confined to the Central Provinces and Berar, it has been specially studied in connection with these provinces, and a reference to the available information may therefore be given in this place.

Precarious.

Rust.

The methods of cultivation and all other details are precisely similar in the Central Provinces to those already described under Bengal and Bombay, and need not therefore be here repeated. Subsequent years to those discussed by Sir James Fuller have manifested an even greater expansion, though severe fluctuations and heavy losses through failure of crops were also recorded. About 5 per cent. of the total cropped area in the Central Provinces is ordinarily under linseed. It cannot be grown more frequently than once in five or six years but it has this advantage, that when wheat and gram give bad returns, linseed, in such seasons, is usually successful, and thus may save the cultivator's position. When cotton or *juar* fail, the land may be suddenly thrown under linseed and a good crop obtained. When grown as a sole crop, linseed is ordinarily sown earlier than wheat, and this is sometimes in its favour. But a large part of the linseed produced is sown as a second crop following rice, and is thus much later. An early cessation of the monsoon would thus injuriously affect the late crop.

Relative Area.

Wheat *versus* Linseed.

Trade in Central Provinces.—The bulk of the production in these provinces is conveyed by train to Bombay, but a fair amount is imported from Rajputana and Central India.

To Bombay.

Agra and Oudh.

3. ***UNITED PROVINCES.***—The two provinces of Agra and Oudh viewed together undoubtedly take the third position in the Indian production of linseed. During 1905–6 the area in the former came to 185,034 acres and in the latter to 60,880 acres, or a total of 245,914 acres. And to indicate the distribution the following figures of the district areas may be recorded. In *Agra Province* :—

Chief Districts.

Gorakhpur, 60,331; Basti, 22,144; Allahabad, 8,803; Mirzapur, 22,581; Hamirpur, 40,959; Banda, 2,457; Jalaun, 6,379; all other districts with lesser areas. In *Oudh Province*:—Gonda, 33,175; Bahraich, 17,120; Sitapur, 3,007; and Kheri, 2,299; all others much smaller areas.

Second Crop.

The system of cultivation pursued in these provinces, and the results obtained, have been so fully dealt with in the ***Field and Garden Crops*** and in the ***Dictionary***, that it is hardly desirable to republish a general statement. The remarks that follow may therefore be regarded as useful particulars gleaned from various sources with a view to supplement what has already been said. In the *Gazetteer* for Bareilly, linseed is described as one of the minor staples that is always sown broadcast, and nearly always as the second (*dosahi*) crop of the year. Of Moradabad it is said that when the rice is cut, advantage is taken of any moisture left in the soil to scratch the ground hastily with the plough and throw a mixture of gram, linseed and barley into it and leave these to take their chance. These are, however, rather exceptional than typical districts in linseed production. Mr. W. H. Moreland, the Director of Agriculture, in his annual forecasts and final reports of the linseed and rape crops of these provinces has for some years past furnished a most useful review of the facts of interest and value. In the report for 1903–4, he observes that linseed is generally sown after the autumn crop. Excessive moisture at the sowing season would appear to be injurious, but rain in December and January is necessary, and if delayed till February the crop is not much benefited.

Trade.

Trade with the United Provinces.—The exports shown in the rail and river-borne traffic of these provinces go almost exclusively to the port of Calcutta. These, in fact, constitute about one-third of the total Calcutta supply, the remaining two-thirds coming almost entirely from Bengal. The total amount of linseed shown in the returns of internal trade of India came in 1904–5 to 12,051,507 cwt., of which Calcutta took 6,915,008 and Bombay 4,561,058 cwt. Hence the two towns named drain practically the entire amount of linseed that is annually produced and in the proportions shown. But in 1906–7 the quantity produced fell to 4,859,773, of which Calcutta took 2,666,604 and Bombay 1,936,053 cwt.

Bombay.

Chief Districts.

4. ***BOMBAY AND SIND.***—In the Western Presidency linseed can hardly be regarded as a very important crop. It, in fact, has hitherto held the fourth, if not the fifth, position among the Indian provinces, with, in 1904–5, 523,968, and in 1905–6, 139,623. That area was distributed as follows in 1905–6:—Nasik, 24,115; Bijapur, 44,662; Khandesh, 16,333; Sholapur, 21,727; Dharwar, 14,013; and Ahmednagar, 12,645; all others with less than 5,000 acres. But the figures for the years 1903–4 and 1904–5 were in nearly every instance double what might be called the normal area in the districts named. The total for the Presidency, in other words, showed in 1903–4 an expansion on the area during 1902–3 of 108 per cent., and on that of five years previously of 149. Mollison (*Textbook Ind. Agri.*, iii., 94–8) furnishes an account of a practical nature regarding this crop in Western India. The following may be given as an abstract of his views:—When grown for linseed (as in India), the seed rate is much lower than when grown (as in Europe) for fibre. In India, a mature crop stands 18 to 24 inches high. The stems rise from the ground some distance, and then branch freely. A linseed crop in flower is, during December–January, a noticeable feature of the black-soil districts, particularly in Khandesh—the common variety with a rich mahogany-brown coloured seed; but a creamy-white variety is sparingly grown in the Bombay Presidency, and to a considerable extent in the Central Provinces. The dry crop *rabi* areas under linseed, wheat, gram and *juar* are more or less interchangeable, depending on the character of the monsoon season, and particularly on the late rainfall.

Linseed *versus* Flax.

Dry *Rabi*.

Deccan and Karnátak.

Best Linseed Country.

From the district areas given above, it will be seen that the Bombay linseed supply comes mainly from the Deccan and Karnátak, very little being grown in Gujarat and none at all in the Konkan. It is raised in the *rabi* season only, and on deep moisture-holding black soil, and on such land is rotated chiefly with wheat, gram or safflower, and sometimes *rabi juar*. The best linseed soil is probably the deep black-soil belt on each side of the Tapti in Khandesh. Linseed is the sole crop of its year. The tillage should be completed by the end of September, and the seed drilled in October at the rate of 10 to 12 lb. to the acre, in rows a foot apart. But the land should be so thoroughly harrowed that weeding may not be necessary, since interculture is usually harmful. The crop is in good seasons ripe by February, and is reaped with a sickle near the ground or uprooted. It is then carried to the threshing-floor and dried, when the seeds readily separate, and are winnowed in the usual way. A full crop may be 500 lb. to the acre, but it is precarious, and often may yield much less. Linseed may therefore, be considered a delicate crop, which in favourable seasons only is grown with particular success.

Supplies drained from.

Chief Centre.

Trade in Bombay.—The port town of Bombay drains its supplies from the Nizam's Territory, Bombay, the Central Provinces and Berar, Rajputana and Central India, the United Provinces of Agra and Oudh, the Panjáb, and Madras. In the returns of traffic carried by rail and river, it is shown that the town of Bombay received in 1904–5, 4,561,058 cwt. ; in 1905–6, 2,586,494 cwt. ; and in 1906–7, 1,936,053 cwt. The most important contributing single centre is the Nizam's Territory. From these supplies are, of course, drawn the Bombay exports to foreign countries, and it is thus instructive to note that one-half comes from the Nizam's Territory—a region very different from that from which Calcutta drains its supplies.

Panjáb.

Chief Districts.

Kashmir.

Kangra.

5. ***PANJÁB.***—Since the time that Baden-Powell wrote his *Panjab Products* (i., 497–500, 522–5) and Stewart published his *Panjab Plants*, a considerable expansion of the area of linseed seems to have taken place. Still, the total area in 1905–6 was only 31,293 acres, the bulk being in Kangra, 12,580 acres ; Gurdaspur, 4,039 ; Sialkot, 3,624 ; Ambala, 1,575 ; Hoshiarpur, 1,927 ; Gujrat, 1,579 ; and Jhelum, 1,309. In Kashmir there is also a fair area, the plant being cultivated up to about 6,000 feet above the sea (Lawrence, *Assess. Rept.*, 1890, 18). The imports into the Panjáb of linseed obtained from Kashmir is an important item in the Trans-frontier trade, and one of increasing value. In 1898–9, these imports were 20,423 cwt., valued at Rs. 88,952 ; in 1901–2, they had become 223,642 cwt., valued at Rs. 15,52,993 ; and in 1903–4 stood at 50,502 cwt., valued at Rs. 3,35,136 ; but in 1906–7 fell to 6,083 cwt., Rs. 41,189. In 1860–3 a company carried out fairly extensive experiments at Sialkot in order to ascertain if flax could be there produced ; they were apparently unsuccessful, for the plant presently grown in that district is entirely for linseed. In Kangra the seed is thrown among the stubble after cutting the rice and springs up without any special cultivation ; it is thus a second or supplementary crop.

Hyderabad.

6. ***HYDERABAD, CENTRAL INDIA AND RAJPUTANA.***—It is unfortunate that particulars cannot be ascertained regarding the production in the Native States, since one or two of these, more especially Hyderabad, are important centres of production. The only sort of conception that can be obtained regarding this, is by a study of the railborne traffic. During the year 1904–5 the Nizam's Territory exported 1,226,202 cwt., and in 1906–7, 850,037 cwt. ; Rajputana and Central India, 951,460 and 182,170 cwt. in the same years ; these amounts, going to Bombay, constituted fully one-half of the Bombay supply.

Madras.

7. ***MADRAS, ASSAM AND BURMA.***—These provinces take so small a share in the Indian linseed traffic that they can be neglected without serious consequences. The reports from the province of Eastern Bengal and Assam were in 1904–5, 85,746 cwt., and in 1906–7 only 45,893 cwt. ; of Madras still less, namely 50,171 and 31,269 cwt.

INDIAN TRADE IN LINSEED AND LINSEED OIL.—In the provincial paragraphs above, mention will be found to have been made of the extent of cultivation and the supply of linseed obtained from the chief producing provinces. It is not necessary to repeat these statements, but a good starting-point in a study of the total linseed trade of India is naturally to be had in the figures of FOREIGN TRADE.

First Exports.

Early Transactions.

Recent Returns.

British Gift to Indian Cultivators.—FOREIGN EXPORTS.—Royle informs us that the first mention of the EXPORTS of linseed from India occurs in 1832, when 3 cwt. were recorded. The very next year the exports were 1,583 cwt. ; in 1839, 120,922 cwt. ; and in 1850, 560,452 cwt. In 1860–1 the exports from India were 550,700 cwt., valued at Rs. 1,25,57,790 ; in 1880–1, 5,997,172 cwt., valued at Rs. 3,69,81,265 ; in 1900–1, 5,060,189 cwt., valued at Rs. 4,45,60,096 ; in 1903–4, 8,616,356 cwt., valued at Rs. 5,74,41,762 ; and in 1904–5 they

Last Year's Exports.

Grown almost exclusively for Export.

Safety-valve.

Prices affect Production.

attained their highest record, namely 11,182,009 cwt., valued at Rs. 6,32,87,256, but sank in 1905–6 to 5,788,860 cwt., valued at Rs. 4,11,55,398, and in 1906–7 still further to 4,378,826 cwt., valued at Rs. 3,25,98,578. The linseed consumed in India represents only about 5 per cent. of the production, hence it is not far from correct when it is affirmed that the traffic as known to us to-day is entirely a consequence of the British administration—a gift to the agriculture of India which covers an area of land, profitably utilised, of approximately four million acres, and gives a production of half a million tons of oil-seeds, which represents a contribution to the earnings of the farmers of three and a half million pounds sterling. Moreover, it is a crop that may be used as a safety-valve, and be increased or decreased according to the owner's advantage. In other words, land is thereby profitably cultivated, in excess of ordinary food necessities, which may be thrown under food crops as occasion arises. But for these very reasons, the traffic is subject to the greatest possible variations. Production depends greatly on local necessities of food, the prices ruling in Europe for linseed, and the relative values of linseed and cotton for the time being. The Argentine Republic has within recent years become India's most formidable rival.

United Kingdom.
Germany.
France.

Out of the total exports in 1904–5, India's record year (total 11,182,009 cwt.), 3,885,776 cwt. were consigned to Great Britain; 2,746,965 cwt. to Germany; 1,889,846 cwt. to France; 1,173,647 cwt. to Holland; and 673,871 cwt. to Italy.

Vicissitudes of Seasons.

High Va

Rent-pa Crop.

Linseed, like wheat, is very readily influenced by the vicissitudes of bad seasons, caused either by drought or blight. But so important a position has the Indian supply secured in the markets of the world, that when the quantity decreases the price, as a rule, rises, thus compensating the producer. But perhaps the most instructive lesson to be learned from the study of the areas of production of linseed, in relation to the returns of foreign exports, is the circumstance that while linseed holds the third position in area, the value and quantity of the seed exported from India are usually very nearly the values and quantities of all the other oil-seeds taken together. And from this standpoint alone, therefore, is derived a fairly tangible conception of the consumption of oils and oil-seeds within India itself, and full confirmation obtained of the statement already made that linseed is grown primarily for the purpose of export: it is a rent-paying crop.

Local Consumption.

Three Separate Returns.

Internal Trade.—The returns published officially regarding the movements of linseed by road, rail and river afford the only really definite conception of production and sale that can be learned. The traffic registered as carried by these routes during the five years ending 1906–7 were, 1902–3, 5,922,967 cwt.; 1903–4, 8,884,004 cwt.; 1904–5, 12,051,507 cwt.; 1905–6, 5,278,659 cwt.; and 1906–7, 4,859,773 cwt. Analysing the record year (1904–5), the total shown under foreign exports (disregarding for the moment the traffic in the oil) came to 11,182,009 cwt., or say half a million cwt. less than the deliveries registered by the railways at the port towns—and that surplus may, therefore, be taken as the amount used up by the local mills or carried forward into next year's stock. A certain discrepancy has, however, to be accepted, due to imperfections in the returns and unavoidable duplications. Still, it can fairly be said that the figures compiled by one department (Railways) provide the exact quantity shown by another (Foreign Exports), and a third line of reasoning might

Calcutta Exports.

Bombay Exports.

Karachi Exports.

be used to confirm both, namely the area of cultivation expressed to the accepted average yield. Viewed from any and every standpoint, we learn that the linseed of India is grown purely and simply in obedience to a foreign demand. As already mentioned, the exports from Calcutta are drawn from the province of Bengal (two-thirds) and from the United Provinces (the remainder); Assam and the Central Provinces contributing between them only about 120,000 cwt., out of a total Calcutta supply of close on 7,000,000 cwt. The exports from Bombay, on the other hand, are drawn from the Nizam's Territory, Rajputana and Central India, the Central Provinces and Berar, and lastly the Bombay Presidency itself, and in the order named. Of the producing provinces (judged of from the railway returns), Bengal heads the list, and is followed by the United Provinces (a good second); by the Nizam's Territory (an indifferent third); by the Central Provinces and Berar (a very poor fourth); then Rajputana and Central India; Bombay; next Assam; and, last of all, Madras. Karachi exports a small amount of Panjáb linseed. Seeing that the Central Provinces have so large an area under the crop, their position as fourth in exports is a little difficult to understand. The explanation is perhaps that the area is shown larger than it should be owing to mixed cultivation being estimated as pure.

Oil and Oil Mills.

Exports.

To Australia.

Oilcake.

Linseed Oil and Oil Mills.—It cannot be ascertained how many of the 99 oil mills, reported to be at work in India, are concerned in the linseed traffic proper. Only one appears to deal exclusively in linseed, namely the Gourepore Company, Ltd., near Calcutta. Their oils and oilcakes are noted all over India. The mill, moreover, produces both boiled and unboiled oils. The exports of linseed oil from India are not very important, nor do they appear to be increasing; in fact, judged of by the returns from 1899–1900 to 1906–7, they have, if anything, been decreasing. In 1899–1900 they were 248,479 gallons, valued at Rs. 4,20,167; in 1903–4, 137,952 gallons, valued at Rs. 3,61,654; in 1905–6, 186,682 gallons, valued at Rs. 4,57,983; and in 1906–7, 114,205 gallons, valued at Rs. 2,18,926. Nearly the whole of these exports go from Bengal, and thus to a large extent doubtless embrace the Gourepore Company's transactions. It is also noteworthy that the major portion goes to Australia and New Zealand. As already mentioned (p. 726) the cake is valued as an article of cattle food when not adulterated with mustard (see pp. 184, 770, 817).

[*Cf.* Hurst, *Lubricants, Oils, etc.*, 1896, 155; Andes, *Veget. Oils and Fats*, 1897, 39; Livache and McIntosh, *Manuf. of Varnishes, Oils, etc.*, 1899, 226–46, 251–302; Allen, *Comm. Anal.*, 1899, 12, 94; Percival, *Comm. Bot.*, 1900, 163; A. Watt, *Art of Soap-making*, 1901, 28, 130; Blyth, *Food Compos. and Anal.*, 1903, 284–5; Wright and Mitchell, *Oils, Fats, Waxes, etc.*, 1903, 39, 178; Sabin, *Ind. and Art Tech. of Paints and Varnishes*, 1905, 39–65.]

Live Stock.

LIVE STOCK OF INDIA.—This very large and important subject may be discussed under the following sections: Oxen and Buffaloes; Sheep and Goats; Horses, Donkeys, Mules, Camels; and Pigs.

Estimate of Total.

British Provinces.

An analysis of the returns of Live Stock in India during 1905–6 manifests the existence of approximately 198 million head of cattle (cows, bulls, bullocks, buffaloes, sheep, goats, horses, mules, donkeys, camels, etc.). The actual figures are 30 million bulls and bullocks, 22 million cows; 13 million buffaloes; 26 million young stock; 18 million sheep; 25 million goats; 2½ million horses, donkeys, mules; and 393,308 camels. The

Estimate for Bengal.

Estimate for Native States.

live stock of Bengal is not recorded, but, since its population is twice that of Madras, it may be assumed to possess double the returned live stock of all sorts met with in the Southern Presidency, viz. 61 million. This gives the 198 millions (above mentioned) as the total live stock, in place of the officinal figure of 137 millions (exclusive of Bengal). But to that total has also to be added the 15 millions shown as owned by the Native States. In fact 30 millions would not over-state the live stock of these States, making a grand total for India of over 228 million cattle of all kinds.

Hides.

Skins.

Exports.

Local Requirements.

Death-rate.

Some such estimate seems essential to allow of comparison with the trade returns, which include Bengal and the Native States. Thus, for example, the term "hides" may be taken to mean undressed skins of full-grown bovine animals, and "skins" those of calves, sheep and goats. For the five years ending 1903–4 the average number of hides (raw and dressed) exported from India came to 12½ millions, and of skins 37 millions; these collectively would, therefore, show 23 per cent. on the estimated total live stock of all India for the period in question. But the exports by themselves take no cognisance of the numbers of hides and skins used up by the indigenous leather industries of India itself, nor of the numbers of animals that die or are killed and the skins, for various reasons, entirely lost. Were a figure to be given for the annual death-rate (from all causes) of the cattle, sheep and goats of India, it is probable that it would be something nearer 70 to 80 rather than the 50 millions indicated by the returns of foreign trade specially dealt with above. For further particulars see the article **Hides and Skins** (pp. 632–9).

I. THE OXEN, BUFFALOES, ETC., OF INDIA.

D.E.P., v., 659 74.

Oxen.

The following is a list of the chief Bovine animals of India that fall into this group:—

Bos indicus, *Linn.*; Blanford, *Fa. Br. Ind.* (Mammalia), 483–4; Mollison, *Textbook Ind. Agri.*, 1901, ii., 63–139; Meagher and Vaughan, *Dairy Farming in India*, 1904, 41–7. The Zebu or Humped Ox, *bail, gai, gau, dhúr* (cattle), *dhúr danger* (horned cattle), *dudhar* (milch cow), etc.

Humped Cattle.

The Indian animal differs from the tame ox of Europe and North Asia in structure, general coloration, voice and habit. Its origin is unknown, but according to Blyth it was probably African. No ancestral form has as yet been discovered among the Indian fossil bovines. Humped cattle have, however, often been reported to have run wild in India. All the breeds of the Indian ox are held sacred by the Hindus and are, therefore, neither killed nor their flesh eaten by a large portion of the people. On the other hand, the tending on cattle is regarded as a highly honourable position, and hence also milk, butter, cheese, etc., are largely consumed by all classes of the community. Below will be found a brief sketch of some of the leading breeds of oxen.

Buffalo.

B. bubalus, *Linn.*; Blanford, *l.c.* 491–3; Mollison, *l.c.* ii., 140–55; Meagher and Vaughan, *l.c.* 47–51, 56; *Note on Export of Buffalos to Australia, Rev. and Agri. Dept. Ind.*, 1885. The Buffalo, *arna, mang, mains, bhains, bir biar, gera crumi, moh, siloi, misip, iroi, kywai, pana, karbo,* etc.

Semi-aquatic.

Wild.

Tame buffaloes are found all over the plains and lower hills of India. They are repeatedly mentioned in the *Institutes of Manu* (xi., 69), so that they have been known from the earliest historic times. They are semi-aquatic animals, and accordingly most abundant in humid localities. Are large, massive, and clumsy creatures, with exceptionally short thick legs and conspicuous hoofs. The horns are thick, flat, curved or straight, and marked with rings indicative of age. The muzzle is large, remarkably square, and the head carried very low. A truly wild buffalo is fairly abundant in India (except in the Southern and Western Provinces), especially in low-lying swampy land covered with tall grass. Few domestic animals have, in fact, changed less than the buffalo. While it will not breed with the ox, the tame buffalo-cow will pair readily with the wild buffalo-bull, the stock being thereby improved, They are powerful draught animals, and the milk is exceptionally rich in butter-fat.

Yak.

B. grunniens, *Linn.*; Blanford, *l.c.* 490; Turner, *Acc. Emb. to Tibet,* 1800, 186, t. x. (from a picture belonging to Warren Hastings); Vigne, *Travels, etc.*, 1842, ii., 277; Hoffmeister, *Travels in Cont. Ind.*, 1848, 362, 374. The Yak or Grunting Ox, *dong, brong-dong, ban-chowr* (the wild): *yak, pegu, chour-gau, kotass* (the domestic animal).

Wild Alpine Species.

Domestication.

Milk.

Chowris.

Hybrids.

In its wild state it inhabits the coldest and most desolate tracts of the Himalaya—being found at a greater elevation than any other mammal. It is dark brown, almost black, with the exception of the muzzle, head and neck, which are often grey. In domestication it becomes smaller and variable in colour, being often pure white or piebald. Mention is made of the *qatas* or "Tibetan yak" in the *Ain-i-Akbari* (1590, Jarrett, transl., iii., 121). It is kept by the Tibetans and various other tribes that inhabit the higher regions, on account of its being a sure-footed pack animal. The flesh is said to be rich, juicy and delicately flavoured. The milk is exceptionally rich (considerably richer than that of the cow), and much of the food of the people consists of curd either fresh or dried and powdered into a kind of meal. The white tails constitute the *chowris* (fly-flaps) sold all over India. The hair is woven into cloth and ropes. In fact the wealth of the people of Eastern Tibet consists in their flocks of yaks. The horns are made into cups and other objects of domestic use and ornament. But the yak breeds freely with domestic cattle. One was sent to England by Warren Hastings, which lived for some years and became the sire of many cross-bred calves, only one of which lived and was successfully crossed by an Indian bull. A cross is common on the North-West Himalaya and is known as the *dhzo, zobo,* etc.; it is fertile and in some localities preferred to the pure yak.

Other Species.—Three other animals belonging to this genus may be here mentioned, but, as scarcely of economic value, need only be exhibited very briefly:—

Mithan.

(*a*) **B. frontalis,** *Lamb.*; Blanford, *l.c.* 487-9; the *Mithan* or *Gayal* of Assam, Manipur, Naga hills, Chittagong and Burma. Said to be partly domesticated by the Kukis.

Bison.

(*b*) **B. gaurus,** *Ham.*; Blanford, *l.c.* 484-7; the *Gaur* or Indian Bison of the hilly forests of the Indian Peninsula, Assam, Burma and the Malay Peninsula, ascending to altitudes of about 6,000 feet. It has occasionally been tamed by the people on the hill tracts between Assam and Burma, but has never, strictly speaking, been domesticated. The horns are in great demand for ornamental work. (See Horn, p. 646.)

Banting.

(*c*) **B. sondaicus,** *Muller & Schleg.*; Blanford, *l.c.* 489-90. The Banting, found in Burma and the Malay Peninsula, Borneo, Java and Bali. It has been more or less domesticated in Java and perhaps elsewhere.

Cattle-breeding.

CATTLE AND CATTLE-BREEDING.—In Europe cattle may be said to be reared for milk and meat, but in India their chief value is as beasts of burden. Horses are all but unknown in Indian agriculture, the bullock being very nearly exclusively used for tillage and transport. Occasionally camels are so employed and buffaloes are highly valued for their milk, though they are too slow to be much in demand for agricultural operations.

Pure Breeds.

Heavy Workers.

Quick Workers.

There are many breeds of indigenous cattle. Nearly all the pure stocks are of one colour—white or grey. In areas where little attention is paid to the subject, mixed colours or piebald cattle are not infrequent. Except in the north-east of Madras, all Indian cattle are horned. The hump is prominent, and more highly developed in some breeds. Bullocks which are suited for slow and heavy work have usually massive heads, long pendulous ears, thick short necks, coarse leg-bones, big feet, much loose skin on the neck, dewlap and sheath, and no particular droop in the hind quarters. Those best suited for quick work have clean heads, fiery tempers, short erect ears, thin necks, compact rounded bodies, small hard feet, a very decided droop in the hind quarters, and little or no loose skin on the neck, dewlap and sheath. Indian oxen, it may thus be observed, are distinguished collectively from the breeds of

Hump.

Europe by the hump on the shoulders, by the deep undulating dewlap, and by the short grunt in place of the ringing bellow of the European ox (*Imp. Gaz.*, iii., 77–89). Many European travellers in India allude to the "hump" as a special feature of the provisions (beef) procurable in India. Thus Terry (*Voy. E. Ind.*, 1622 (ed. 1777), 89 90) says the "beeves" differ from ours in being smaller and in having "each of them a great bunch of grisly flesh which grows upon the meeting of their shoulders." He then adds that the flesh is very sweet and tender.

Most Sacred of Animals.

There are few subjects in which India is so very backward as those of Cattle-breeding and Dairy Farming, hence the available literature is comparatively insignificant and defective when judged of in the light of their importance. This is the more surprising since, with a large proportion of the people of India, the cow is the most sacred of all animals. In the *Ain-i-Akbari* (1590) special mention is made of the veneration in which it is held. Linschoten (*Voy. E. Ind.*, 1598, i., 257, 300), Bernier (*Travels*, 1656–68, in Constable, *Or. Misc.*, i., 326–7), Tavernier (*Travels Ind.*, 1676 (ed. Ball), ii., 217), and many other European travellers in India, dwell on the sacred character of the Indian cow. It might naturally, therefore, have been expected that the cow, and some at least of the products it affords, would have existed in even a higher or more fully developed condition than is the case in most other countries.

Climatic Influences.

Local Selection.

Foreign Strain Undesirable.

Draught Animals.

Trotting Bullocks.

Milch-cows.

Fitch.

While there are certain Indian breeds of cattle that compare favourably with those of other parts of the world, most are inferior in size and strength as well as in quantity of meat and milk which they provide. The breeds vary directly with the soil, climate and food of the countries in which they live. For example, in deltaic tracts the oxen are inferior but the buffaloes superior. Meagher and Vaughan very rightly observe:—"The great variations in the Indian climate largely affect the milk yield of cattle imported from foreign districts. Hansi-Hissar cows will not prove as satisfactory say in Jabbalpur, as they will in Delhi or Meerut, and this should be borne in mind before condemning the Hansi-Hissar breed. It appears to be a fact that the further they travel east or south (*i.e.* the damper the climate becomes), the more certain is the decrease in the yield." Climate, soil and available food in fact influence so rapidly the breeds of cattle that it becomes undesirable to extend schemes of improvement very much beyond selection from existing stock within each area. Indeed for the plains of Lower India, crosses of foreign strains, more especially from Europe, have proved highly unsatisfactory. The chief difficulty is to overcome the opposition that exists in transferring, without loss of special merit, the stocks even of one part of India to another. If the intention be to improve, as heavy draught animals, the breeds of the Panjáb, Gujarat and Mysore afford ample material: if the desire be for swiftness, the trotting bullocks of the Central Provinces and of South India (*gainis*) are unsurpassed anywhere: and, if milch-cows be sought, there are several famed breeds, such as the Nellore or Ongole and the Gir of Kathiawar and the Hansi-Hissar of the Panjáb. In the *Ain-i-Akbari* (Blochmann, transl., 149) special mention is made of the Gujarat breed of cattle and of the small swift-footed *gainis*. This is curiously confirmed by Ralph Fitch (in *Purchas' Pilgrimes*, 1625, ii., 1733), who, while telling of his visit to the Emperor Akbar in 1585, specially mentions the carved and gilded carts of Agra and Fatehpur drawn by "two little bulls about the bignesse of our great Dogs in England.” [*Cf.* Tavernier, *l.c.* 44; Terry, *l.c.* 144–5, 187.]

No Hindu Development.

Akbar's “Cow Stalls.”

Haider Ali's Military Breed.

But, excepting at the homesteads of the wealthy or at the experimental farms owned by Government, special selection of stock or the rearing of healthy, well-formed bulls for service purposes is practically unknown from one end of India to the other. The story told by Abul Fazl of the “Cow Stalls” kept by the Emperor Akbar reads more like a proclamation of the pageant of the all-wise and good Emperor than a statement of his efforts towards the improvement of the cattle of India. The Amrit Mahal breed is said to have been introduced into Mysore and specially developed by Haider Ali for military purposes. But history tells of no Hindu Prince who devoted anything like the attention Akbar bestowed on this most important subject.

Traditional Knowledge.

Bull Neglected.

Bulls presented to Districts.

Local Selection.

Crosses.

Indian agriculture has for centuries been and is to-day essentially a peasant industry. It is in the hands of persons who have the traditional knowledge of their ancestors to guide them, but absolutely no capital beyond that absorbed in daily necessities. Each person, as a rule, keeps but two or three cows, and cannot afford to keep a bull. And moreover, since the male offspring are not generally emasculated until they are three years old, the cows are served by immature and as often as not diseased, degenerated or otherwise undesirable males. Improvement of the breed under these conditions is naturally very difficult. For some years past, however, the Government of India have recognised the obligation of initiating a reform, and with this in view have had superior bulls reared at special farms (such as those of Hissar, Charodi, Pusa, etc.) and presented to districts where it was desired to improve the local breed of cattle. Voelcker alludes approvingly to this action, and urges that the satisfactory results attained should be pushed forward until the remotest corners of the Empire have been reached. So also the Government have aided very greatly by encouraging local fairs and cattle shows, by awarding special prizes on the verdict of high expert officials who have been deputed to visit the shows for that purpose. But it is well known that half-bred cattle contract rinderpest and other common diseases in a most virulent form and rarely recover under treatment, while many indigenous breeds are comparatively immune. This has accordingly led to belief that the best results are likely to be obtained by breeding strictly within carefully selected and special local stocks, not promiscuous inter-breeding of all races.

Breeds of Buffaloes.

Early European Opinion.

(*A*) ***Chief Breeds of Indian Buffaloes.***—The breeds of buffaloes have not as yet been critically studied. Until this has been done, little more can be accomplished here than to indicate those most frequently spoken of. Terry gives a curious reference (*Voy. E. Ind.*, 1622 (abrid. ed. Havers), 1665, 359) to “a very large beast having a smooth thick skin without hair called a buffalo which gives good milk; the flesh of them is like beef but neither so toothsome nor wholesome.”

Rice-growing Tracts.

Colour.

In rice-growing tracts buffaloes are extensively used for tillage and cartage work. But although they thrive well in wet climates, the best breeds are met with in localities of moderate rainfall and under the conditions best suited for cattle-breeding. But buffaloes must have access to water, and require to be bathed once or twice a day if they are to be kept in health. It is also customary to clip off their sparse coat of hair once or twice a year. Buffaloes vary in colour, but the majority have black, shining

Bulls Starved or Killed.

Transmission of Milking Property.

skins. Some have white markings and a few are grey, light dun or white. Their lowing differs from that of kine and they have no hump. Most writers allude to the fact that it is difficult to get a good buffalo-bull, owing to its being less valuable than the buffalo-cow. The bulls are not often reared, but are either purposely starved or killed. They attain maturity at 3½ years and are used for stud purposes for not more than 7 or 8 years. "It is just as essential when starting a dairy, to get a good bull as to get good cows, for many authorities now hold that it is from the sire, and not so much from the dam, that a heifer inherits her milking powers." Middleton, who has kindly perused this review of Indian information, observes that the milking properties may be transmitted by either sex equally, but in England bulls are usually more carefully bred than cows and may so transmit properties with greater certainty.

Buffalo-horn.

Curved.

Straight.

Considerable commercial interest is taken in the shape of the buffalo-horn, the straight forms being of greater value than the curved. From the standpoint of the dairy farm, the breeds with curved horns are apparently the most highly appreciated. The following are mentioned by authors as the characteristics by which the chief breeds of buffaloes may be classified :—those with horns approaching a circle (the ***spiroceras*** of Hodgson), and those with the horns long, straight, the tips only arching forward (the ***macroceras*** of Hodgson).

Delhi.

Horns curled up.

1. **Delhi.**—The breeds of the United Provinces, the Panjáb and Sind are often collectively designated "Delhi Buffaloes." The horns are short, thick at the base, sharply angled, and rise from the head in a backward and upward course, then become completely curled up like the horns of a ram. According to Meagher and Vaughan (*l.c.* 47–8) the best buffaloes of this kind are the *murrah*, procured in Hansi-Hissar, Rohtak, Jhind and Nabha. The name given to them is derived from *murna* (= to turn), and is an allusion to the form of the horns. They are sometimes also called *kundi*, and cross-breeds with this and the inferior village buffalo (with straight horns) are called *dogla*. [Pease, *Agri. Ledg.*, 1895, No. 22, 408; Hadi, *Agri. Ledg.*, 1895, No. 12, 206–8.]

Surat.

Straight Horns.

2. **Surat and Deccan.**—The buffaloes of Surat and the Deccan are very different. They both have what are called straight horns. That is to say, in the Surat animal they extend along the side of the neck, then turn up near the shoulder with an inward graceful curve; and in the Deccan breed are even straighter, and extend backwards to the shoulders before becoming arched.

Jafferabad.

Massive Short Horns.

3. **Jafferabad**.—In the Jafferabad (Kathiawar) buffalo the horn is very massive and coarse. It is flat and broad below, developed at first downwards and backwards, then curved forwards, thus forming three-quarters of a circle, placed on either side of the head. But there is still another peculiarity. The frontal bone becomes greatly developed until it causes the horns to appear united across the forehead. This is a very large, clumsy animal with unusually long legs and large spreading feet.

Hill (dun-coloured).

4. **Dun-coloured Buffaloes**.—Here and there all over India, more especially in hilly districts, remote from swampy country, a dun-coloured buffalo is met with that seems very distinct from the other breeds. This has by zoologists been regarded as possibly a distinct variety, and has received the name of ***B. bubalus, var. fulvus.*** Meagher and Vaughan say these dun or brown buffaloes generally start well but end badly. They are not as a rule heavy milkers for any length of time.

Burma and Assam.

Long, Straight Horns.

5. **Burma and Assam.**—Varthéma (*Travels*, 1510 (ed. Hakl. Soc.), 200–1) speaks of the breeds of Tenasserim as very "misshapen." Many subsequent writers have incidentally mentioned the buffaloes of Burma, but no one apparently has studied them comparatively with the breeds of India. Evans (*Agri. Ledg.*, 1895, No. 10, 165–72; 1896, No. 10) gives, however, many particulars of the Burmese breeds. They would seem to have long, so-called straight horns, like those of Surat. They give very little milk. The buffaloes of Assam have been discussed in some detail by Darrah (*Agri. Ledg.*, 1894, No. 14). He tells us that though the stock is regularly imported from Bengal, the animals soon improve on the rich pastures of the Brahmaputra valley.

(*B*) ***Chief Breeds of Indian Cattle.***—Very little strictly speaking of a scientific nature has as yet been published on this subject. Wallace and Voelcker have each given the results of their rapid tours of inspection through India, and numerous local writers have extolled the merits of certain breeds with which they were familiar. No one has as yet critically and comparatively examined all the breeds of India. Little more, therefore, can be here attempted than to amplify the particulars of the cheif breeds (given in the *Dictionary*) in the light of the additional information brought out by the various writers in *The Agricultural Ledger*, and by Mollison in his *Handbook* and by Majors Meagher and Vaughan in their *Dairy Farming in India, etc.*

Gujarat.

1. **Gujarat.**—These are the indigenous cattle of the plains, Ahmedabad, Kaira and Baroda, also the hilly countries of Palanpur and Deesa, where a large breed of very superior animals exists. They are, in fact, the finest cattle of India for general agricultural purposes. In the more southern portions of the province, however, a mixed and inferior breed occurs which in many respects resembles the Deccani cattle. The larger and superior race is in colour from white to bluish-grey, the head, neck and limbs often being of a darker tint than the body. The horns are somewhat bowed and curve outwards as they leave the skull, then upwards, and lastly inwards. The animals are tall and somewhat leggy, but very powerful, and for draught purposes, especially when crossed with Mysore, are very valuable. [*Cf.* Ovington, *Voy. to Suratt*, 1689, 253–5, 273–85.]

Draught Cattle.

Gir.
Milch Cows.

2. **Gir or Kathiawar.**—This breed is specially noted for its milk-giving powers. It is extensively reared in herds in the Gir forests and hills of South Kathiawar. They are coloured animals, often speckled or "roan," in various shades of red and brown. The long, pendent lop-ears and short crumpled horns are striking peculiarities. In Bombay they are generally called "*Surtis*," because brought *viâ* Surat.

Sind.

3. **Sind and Aden.**—This small-sized animal is powerful though lazy, but the cows are remarkably good milkers. The horns are short, thick, blunt-pointed, and project outwards and upwards. The best are bred within a radius of 30 or 40 miles from Karachi, and chiefly on the lower hills, where good grazing is to be had. The breed may, however, be met with through Rajputana and the Southern Panjáb. [Mollison, *The Montgomery and Sind Breeds of Cattle*, in *Agri. Journ. Ind.*, 1907, ii., pt. iii., 252–6.]

Deccan.

4. **Deccan, Khandesh and Southern Maratha Country.**—It cannot be said that the regions indicated have developed any very special breeds of their own. Large portions of the country are subject to periodical scarcity and occasional famine, and the animals have become hardened and thus acquired their chief characteristic. The dewlap is inconspicuous, the forehead narrow and the muzzle large, while the horns spring in an upward direction, then bow abruptly outwards and ultimately inwards. The cows are poor milkers, and the bullocks, though small, are extremely active and have great powers of endurance, if not given too heavy a task. They are accordingly much used in light carts or as trotting bullocks. So long ago as 1503, Vertomannus (in *Hakl. Voy.*, 1811, iv., 577), speaking of the Deccan, said, "It hath innumerable kyne of shynyng yelowe."

Trotting Bullocks.

Mysore.

5. **Mysore and Coorg.**—The cattle of this region are celebrated both for their swiftness and for their spirit and powers of endurance. If cattle-breeding could anywhere in India be viewed as having attained the position of a recognised principle of agriculture, to Mysore would have to be assigned that honour. Two descriptions exist side by side, each serving its own particular purpose. The first and by far the most numerous is the *nadudana* of the villages. This is the agricultural stock and main source of the dairy produce of the State. The second is the *doddadana* or big cattle. This embraces the following special breeds:—Amrit Mahal, Hallikar, Chittaldrug, Mahadeswara, Betta, etc. The first mentioned—the Royal *Amrit Mahal*—is the most highly prized, but is neither the largest nor the most powerful. These splendid animals are capable of performing quick journeys of long distances with a light and moderate load. They are large and powerful animals, chiefly kept by the well-to-do. The finer breeds are pure coloured, the inferior often mottled. There is no extra development of the dewlap to interfere with their trotting action. Their eyes are deep-set, the forehead bulges above the eyes and slopes backward. The ears are short and pointed,

Agricultural.

Active and Powerful.

and the horns, which spring close together, take a backward sweep, gradually diverge, and near the extremity curve gracefully upwards and forwards. They are all, even the *nadudana* breeds, powerful draught cattle but poor milkers. [*Cf.* Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, i. (many passages); Kristnamangar and Pease, *Cattle of Mysore*, in *Agri. Ledg.*, 1895, No. 24; Kristnasamiengar, *Diseases of Mysore Cattle*, *Agri. Ledg.*, 1896, No. 28.]

Madras.

Milch Cows.

6. **Madras, Nellore, Kistna (Ongole), etc., Cattle**.—The Ongole breed of cattle is reared chiefly in the districts of Nellore and Kistna. From early times it has enjoyed a well-earned reputation of being one of the best milking breeds of India. Most writers agree, however, in saying that they degenerate rapidly when removed to other localities. The valleys of the Kistna and its tributaries have a rich, soft, deep black soil, and naturally therefore the cattle of such a country are not well suited for hard roads, unless carefully and regularly shod. They are collectively heavily built animals, docile and of a mild and gentle disposition—essential qualities for milch-cattle—but sluggish in action. The head is erect on a short, stout neck. The horns are short and stumpy, somewhat resembling those of Sind cattle, and longer in the cows than in the bulls. They give to the head a curious and characteristic appearance, the bulging forehead forming a very obtuse angle. The prevailing and true colour is white with grey or black points, and frequently the bulls are black about the neck and shoulders—broken colours indicate impurity. In point of size they are inferior to the Gujarat and Nagar cattle.

Special Breeds.

Other Madras breeds are the Alambadi of Salem and Coimbatore; the Baragur of the hills of Coimbatore; the Kangayam of Madura; the Palikolam (Jellicut) cattle of Madura; the small Trichengodi cattle of Salem; the artificially spotted cattle of Tanjore; and the Punganur cattle of North Arcot. [*Cf.* Pease, in *Agri. Ledg.*, 1895, No. 7; Sabba Rao, in *Agri. Ledg.*, 1896, No. 12; Holmes, *Hair-markings on Horses and Cattle, Dept. Land Rec. and Agri. Mad. Bull.*, 1900, No. 42; also *Notes on Cattle of Madras Pres.*, *Bull.* No. 44; Gunn, *The Nellore Breed of Cattle*, in *Agri. Journ. Ind.*, 1906, i., pt. iii., 237–42.]

Burma.

Well cared for.

7. **Burma.**—Very little has been written regarding the cattle of Burma, so that it is not possible to assort them with the Indian breeds. Red is the dominant colour. The horns, when not interfered with, take an upward and forward direction and grow to a length of 10 to 18 inches. The neck is short and powerful and the dewlap not much developed. The Burmans are most considerate of their cattle, never overworking them, and grooming them carefully on the close of the day's task. The animals are also well-fed, so that they are naturally much superior to the imported cattle from India. But as milk-producers the Burman cows occupy a very low place, owing to the prejudice entertained by the Burmans against the use of milk. [*Cf.* Frost, *Note on Cattle of Burma*, 1889; also *Quart. Journ. Vet. Sc. Ind.*, 1890; Evans, in *Agri. Ledg.*, 1895, No. 10; *Rept. Rev. Admin.*, 1889-90, 47–8; *Settl. Repts* (many); also *Dept. Agri. Ann. Repts., etc.*]

Bengal.

Sacred Bulls.

8. **Bengal and Assam**.—The ordinary village cattle of these provinces might practically be spoken of as the most inferior in India. They are small overworked and half-starved animals of which little more can be said than that they are suited to the climatic conditions and soils of the countries in which they live. In certain localities, such as Bihar and Tirhut, considerably better breeds exist, most probably a consequence of the continual importation and crossing of fresh stock. In Gaya, for example, it is not uncommon to find an animal supposed to have been derived originally by crossing the Indian cow with an English "short-horn" bull imported in 1857. "Bihar is overrun with *pols* (bulls dedicated to the gods). These are very fat, and comparatively useless for stock purposes, but do much harm in eating and trampling the growing crops." [*Cf.* Buchanan-Hamilton, *Stat. Acc. Dinaj.*, 221–8; also in Montgomery Martin, *Hist., etc.* (many passages); Banerjei, *Bankipore Cross-bred Cattle*, in *Agri. Ledg.*, 1895, No. 25; Darrah, *Cattle of Assam*, *Agri. Ledg.*, 1894, No. 14; Mukerji, *Bengal Cattle*, *Handbook Ind. Agri.*, 1901, 578–93; *Imp. Gaz.*, iii., 77–89.]

C. Prov.

Nimar.

Arvi.

9. **Central Provinces**.—The stock is often very mixed. In Nimar, red and brown coloured animals prevail, and in other districts white predominate. The Nimar is, however, generally held to be the best breed. It is a medium-sized animal. Mollison says that it may be recognised by two peculiarities in the colour of the skin and shape of the horns. They are red or brown mottled, but the red is always light, sometimes almost yellowish, and the white markings are never pure white. The horns are thick at the base, blunt, flattened and curled over the head like those of the Delhi buffalo. They are chiefly valued for agricultural work and as draught bullocks. The Arvi cattle of these provinces closely

resemble those of Nellore. The bullocks are strong, but not active. [*Cf. Repts. Land Rev. Settl.* (many districts); Trydell, in *Agri. Ledg.*, 1898, No. 18; *Ann. Repts. Dept. Agri.*; *Exper. Farm Repts.*, etc.]

U. Prov.

10. **United Provinces of Agra and Oudh.**—Throughout Oudh, the *nánpárá* breed ranks high. But there is a sub-breed known as the *risia*, which is smaller in size, more leggy and quicker tempered than the *nánpárá*. The horns in both are elegant, thick below, and tapering to a fine point. One important feature is a slight but distinct depression on the forehead which makes it easy to distinguish the Bahraich from the Doab and Mathura (the *kosi*) cattle. The cows of Kosi and Chhata are celebrated for their milking qualities, and the bullocks have the reputation of being good draught animals (see No. 13 below). The breeds of Kheri are, however, far superior to those of Bahraich, and much resemble the Malvi of Central India and Rajputana. In fact Kheri occupies the most prominent position amongst all the districts of Oudh, being famed for its so-called *parchar* cattle, sometimes spoken of as *bangar*. White is considered the best colour and black the worst. The bullocks are fast walkers, have a highly irritable temper, but possess great powers of endurance. Other breeds may be named: —*Bhur*, *Khairigarh*, *Majhra-Singahi* and *Dhaurahra*. [*Cf.* Sayyid Mohammed Hadi, *Bahraich and Kheri Cattle*, in *Agri. Ledg.*, 1895, No. 12; also *Mathura*, No. 19; Leather, *Barabanki Cattle*, *Agri. Ledg.*, 1895, No. 17; *Ann. Repts. Civil Vet. Dept.*, 1902, 2, *et seq.*; *Prov. Gaz.*, 1903-4 (many district accounts).]

Nánpárá.

Kosi.

Bangar.

Panjáb.

11. **Panjáb.**—"It may safely be said that the best milch-cows of Upper India are obtained from the Hansi-Hissar district, and they are commonly termed Hansi cows." With these words Meagher and Vaughan open their chapters on the "Best Milking Breeds." Speaking of the Harriana cattle, Pease describes the region in which they are produced as "the green country which comprises about 292 villages of the Hissar district chiefly in the Hissar and Hansi Tahsils and the greater part of the Rohtak district." The region in question has a good soil, passing into clay-loam in one direction and into sand in the other. The average rainfall is 16 inches, and the climate, therefore, is dry and well suited to cattle. But the increase of cultivation within recent years has curtailed the pasture lands and lessened the interest in cattle-rearing. Still the country indicated produces a large surplus of cattle regularly exported, as also a very important supply of *ghi* traded in all over India. The Hansi-Hissar cattle are uniform in colour; broken colours are seldom, if ever, met with. The skin is usually dark coloured and the hair white or grey, but darker at the shoulders and neck, and on the flanks sometimes almost black or blue. Red-coloured examples are rare and usually inferior. The horns are short, set wide apart and arch outwards, upwards and then inwards, but only slightly forwards. Meagher and Vaughan, while apparently accepting the Hansi as the best breed for Upper India, give several illustrations of the Sanhiwal sub-breed, which would appear to be frequently broken coloured—red or mixed colours—white being rare. According to many writers, the Montgomery cattle are powerful rivals of the Hansi for the claim of first position as a milk-yielding stock. They are small, shapely and short-legged animals with exceptionally long tails. The Director of Agriculture, in July 1903, drew up a statement of the breeds of cattle in the Panjáb, in which he adds to the above the Kuchi or Chenab breed; the cattle of the Jhang district; the Dera Ghazi Khan breeds; the Dhanni cattle of the Salt Range; and the Maja cattle of the uplands between the Sutlej and the Ravi. [*Cf.* Pease, *Cattle of Harriana and Sirsa*, *Agri. Ledg.*, 1895, No. 22; Meagher and Vaughan, *Dairy Farming in India*, 41-59; *Repts. Civil Vet. Dept.*, 1895-1900.]

Hansi.

Ghi.

Kuchi

Dhanni.

Maja

Rajputana.

12. **Rajputana, Central India, Berar and Hyderabad.**—The animals of a large portion of the tracts of country indicated naturally approximate very closely to the Hansi breed already briefly indicated. The characteristic cattle of Rajputana and Central India are invariably pure white, though grey or silver-grey specimens are occasionally seen, but broken and mixed colours are unknown. As in other large areas, there may be said to be two sub-races—a large animal specially selected and used by the well-to-do as trotting or fast walking animals, and the ordinary village or agricultural breed. Mollison calls these collectively *Malvi* (or *Malwi*) cattle, and Major Kemp speaks of the high-class animal as the *Nagore* (or *Nagar*) and the agricultural the *Rinda* (small) breed. It would seem that throughout the country indicated local names are often given which, like "Nagore," originated from the name of a village or locality specially noted for the superiority of its cattle. Mollison observes that "the head is short, the eyes

Trotting.

Village Breeds.

Malvi.

are dark, prominent and have a docile appearance. The ears are short with little or no tendency to droop. The horns are very characteristic. They are moderately thick at the base, of fair length and are sharply pointed and invariably spring in a forward and upward direction from the head with a graceful outward bend." Prof. Wallace describes the horns as resembling two arcs of a circle set on the crest of the head with the concavity inwards. They are much prized as heavy draught animals, and are accordingly frequently seen all over Central and Western India. They are very strong, but not swift ; being reared on stony ground, have hard feet and do not require shoeing even when worked on metalled roads (Col. Gerard). They are very largely bred in the territories of H.H. the Maharaja Holkar and H.H. the Maharaja Sindia and the cows are often not milked at all, and in consequence when used as milch-cows are a very inferior stock.

Nizam's Dominions.

The Khillari cattle of the Satpura hills (in Holkar's territory extending to North Khandesh), according to Mollison, were derived originally from Mysore and should be spoken of as the Amrit Mahal breed. Mollison adds, "The fact that Khillári are now bred true to a particular type in a district where Malvi cattle are also extensively reared is a clear indication that the breeders know the advantage of keeping a good strain as pure as possible." Mr. Ali Abdoola describes four breeds, met with in H.H. the Nizam's Dominions, that take their names after the towns in which reared. Commenting on these, Vet. Major W. R. Hagger observes that from the description of the prevailing colours "some seem to have a strong strain of Mysore in them, some show a Deccani cross, while others seem to resemble the Malwi breed." [*Cf.* Kemp, Powlett, Reynolds, Hendley and Hagger, in *Agri. Ledg.*, 1900, No. 21 ; Gerard and Abdoola, in *Agri. Ledg.*, 1900, No. 22; *Gaz. Rajputana* (*Ajmir*), 1904, i., A., 49-50.]

Hill Cattle.

13. **Hill Cattle**—The cattle seen on the higher cultivated Himalaya are small sturdy animals with short, thick legs. They are admirably suited to the regions in which found, and are very active and wild. They are mostly black in colour, though occasionally dun or mottled examples are met with. They are well protected from the severity of the winter by a thick, shaggy coat. The hump and dewlap are hardly if at all present, and, as pointed out by Walker, they much resemble the Kerry-Dexter cattle of Great Britain and Ireland. The cattle of the lower tracts, being annually taken to the grazing lands of the Bhaber country, have been crossed with the breeds of the adjacent plains. In the higher tracts the pure hill breeds are met with, and these are spoken of by names denoting regions or special sub-breeds. The males are used for ploughing, but their working qualities are poor and many refuse to work at all, while the cows are poor milkers. In a further paragraph will be found particulars of the traffic from Nepal to the plains of India in live stock. [*Cf.* Walker, *Kumaon Cattle,* in *Agri. Ledg.*, 1899, No. 7 ; Lawrence, *Valley of Kashmir*, 358–60.]

[The following enumeration of publications, in sequence of date, may be found useful:—Thevenot, *Travels in Levant, Indostan, etc.*, 1687, pt. iii., 51–2 ; Buchanan-Hamilton, *Journ. to Mysore*, 1807, i., 164–6 ; ii., 14, 277, 382 ; also *Hist. E. Ind.*, ii., 891–7 ; Baden-Powell, *Pb. Prod.*, 1868, i., 151 ; Wallace, *India in* 1887 ; Voelcker, *Improv. Ind. Agri.*, 1893, 198–216 ; *Exp. Farm Rept., Poona*, 1893, 11–4 ; 1895, 21-5 ; 1896, 20–5 ; AGRI. LEDG. :—Leather, *Farm-yard Manure*, 1894, No. 3 ; Mollison, *Management of Dairy Cattle in Ind.*, 1895, No. 6 ; Leather, *Ind. Manures*, 1897, No. 8 ; Walker, *Measurement of Cattle*, 1899, No. 8. Subbiah, *The Housing of Cattle and Conserving of Manure, U. Prov. Bull.*, 1901, No. 14 ; *Stat. Atlas of Ind.*, 1895, 33–4 (2 maps). *Dairy Cows*, in *U.S. Dept. Agri. Bull.*, 1900, No. 68 ; *Feeding Exp. with Dairy Cows*, in *U.S. Dept. Agri. Bull.*, 1901, No. 114 ; *Formation of Beef and Dairy Cows*, in *U.S. Dept. Agri. Bull.*, 1902, No. 143 ; *Reed. of Individual Cows, Univ. Illinois. Bull.*, 1903, No. 85 ; Pierre and Monteil, *Le Bœuf au Soudan*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. i., 364–77.]

D.E.P., iii., 407-37.
Cattle Food and Fodder.
Conditions of Rearing.

CATTLE FOOD AND FODDER.—There may be said to be two conditions of cattle-rearing in India—(*a*) village or agricultural, and (*b*) prairie or nomadic. The latter consists of large herds fed on fertile non-cultivated lands, the former small herds or solitary animals reared at the homesteads, thus mostly on cultivated lands. It is generally said, moreover, that the advances of cultivation are rapidly curtailing the areas of nomadic production and thereby cutting off the sources of supply of

Hay-making. Famine.

superior breeds. Hay-making is not practised by the Indian cultivators, and the surplus of naturally produced grass is thus left to waste. Moreover, the cost and difficulty of transport preclude the equalisation of supplies, hence in seasons of drought the greatest hardships have to be endured, and the first indication of famine is the increasing death-rate of the cattle. For example, during the famine years of 1899–1900 something like 70 to 80 per cent. of the cattle perished in certain districts of Bombay, notwithstanding the large imports of fodder made by Government, for the railways were unable to cope with the burden thrown on their resources in conveying food and fodder to the famine-stricken districts.

Source of Poverty. Increase of Cattle. Special Fodder. **D.E.P., v., 463–78. Oil-cake.** Dry Food.

It has sometimes been upheld that cattle represent the *raiyats'* capital. They certainly provide the labour for ploughing and carting, as well as very largely supply the manure and fuel used by their owners. In return the animals get what they can pick up (after the crops are off the fields) and what they can discover on the waysides and waste lands. Nevertheless they often become the cultivator's greatest source of poverty and danger. They increase beyond the needs of the neighbourhood, and thus rapidly change the character of the vegetation: noxious weeds survive and nutritious plants are gradually exterminated. Thus are the village cattle themselves not only depraved and starved, but the natural fertility and humidity of the soil lowered to such an extent that any untoward climatic disturbance only too frequently means famine. Of few localities can it be said that special food or fodder is grown for the cattle, but where this is done, as, for example, the cultivation of the cluster-bean, ***Cyamopsis psoralioides*** (p. 449), and of fodder crops of ***Sorghum vulgare*** (of which the races known as *sundhia, dudhia, nilva,* etc., may be mentioned, p. 1039) in Gujarat and Jhang, etc., etc., the superiority of the cattle in these regions has been frequently attributed to that circumstance. It is of course customary to give rich foods (including several kinds of oil-cake) to milch-cows and to bullocks in daily work. Mollison reviews the opinions that prevail in India regarding linseed, *til*, *niger*, safflower, ground-nut, cocoanut, and cotton-seed cake. [*Cf.* Leather, *Agri. Ledg.*, 1897, No. 8.] It is somewhat remarkable, but true, that a very large percentage of the draught bullocks of India are fed exclusively on dry food. It is of course very generally believed that green food is not suited to working cattle. This is, however, a very different question from that of the conditions of life and the food-stuffs essential to systematic breeding, where the improvement of stock is a distinct feature. The contrast between the bullocks belonging to the European planters in Tirhut and those of the Bihar peasants, or between the bullocks owned by the Burmans and those possessed by the Hindustani residents in Burma, abundantly exemplify the difference between carefully reared and properly tended cattle and those brought up under a system of indifference and neglect.

Upland Grass. Classification of Fodders.

In the *Dictionary* will be found a complete enumeration of the trees, shrubs, herbs and grasses known to be of value as cattle food and fodder. Excellent pasturage exists in most provinces, especially on the lower hills and great Himalayan range. Open stretches of grass-land (*maidans*) often extend from the upper limits of the forests towards the snow-line. On these uplands vast herds of sheep and goats are to be found, the latter affording the much prized *pashm* wool (hair). But on the lower Himalaya the cattle are largely fed on the leaves of four species of oak and a few other trees. The grass that exists abundantly in these tracts is as a rule cut and dried as hay in order to be exported to the plains. The extent to which leaves are utilised as cattle fodder is a speciality of India.

Rice Straw.

In the deltaic tracts and rice lands generally, the cattle are miserably poor. Grazing lands are limited, or totally wanting, and the only fodder available in any quantity is rice straw, which provides scant nourishment. Moreover, it may be said that little or no concentrated food is given even to the work cattle in busy seasons. In peninsular India, good grass is not found where the average annual rainfall much exceeds 40 inches. In some parts of that vast area, therefore, the cattle are extensively fed by hand on the produce of arable tracts (*Imp. Gaz.*, iii., 86). The grazing lands of India and the grazing rights of the people are highly controversial questions. Voelcker (*Improv. Ind. Agri.*, 169–97) discusses these very freely, and his views have on the whole been upheld by subsequent experience. But the almost complete absence of special fields of cattle food is perhaps the aspect of Indian farming that strikes the visitor as most significant. The possession of immense herds, reared on waste lands, accounts very largely for the *ghi*, which is so much traded in all over India; but one of the surest signs of the devastation caused through failure of the rains is the sudden rise in the exports from India of cheap hides—a melancholy consequence of the starvation of these unprovided-for herds.

Absence of Cattle Food.

[*Cf.* Benson, *Ind. Fodder Grasses*, in *Agri. Ledg.*, 1892, No. 1; Watt, *Ground-nut as Cattle Food and Fodder*, 1893, No. 15, 87 *et seq.*; Leather, *Silage-making in India*, *l.c.*, 1894, No. 2; *Feeding Exper.*, *New York Agri. Exper. Station Bull.*, 1897, No. 141; Wood, in *Journ. Board Agri*, 1899, vi., 311–32; Walker, *Measurement of Cattle*, *Agri Ledg.*, 1899, No. 8; Leather, *Food-Grains and Fodders of India*, *l.c.*, 1901, No. 10; Mollison, *Textbook Ind. Agri.*, 1901, ii., 11–41, 48–52; Mukerji, *Handbook Ind. Agri.*, 632–42; Meagher and Vaughan, *Dairy Farming in Ind.*, 1904, 1–14; *Settl. Repts.*, especially those of Burma, deal fully with the fodder supplies and grazing rights.]

Diseases of Cattle.

DISEASES OF CATTLE.—*The Agricultural Ledgers* enumerated below contain many valuable papers on the diseases of cattle. The more serious and special diseases are briefly:—

Rinderpest.
Anthrax.
Foot and Mouth
Pleuro-pneumonia.

1. ***Rinderpest***—the *bossonto*, *güté*, *kalawah*, *pitchinow*, *peya*, *kyaukpauk*, etc. 2. ***Anthrax***—the *golafula*, *gutherewan*, *goli*, *suth*, *odro*, *thalorinora*, *daungthan*, etc. 3. ***Foot and Mouth Disease***—the *khurat*, *aosha*, *khurpakka*, *mohona*, *mupaung*, *sha-na-kwalna*, etc. And 4. ***Pleuro-pneumonia***—the *phípri*, *asok-yaw-ga*, etc. In a special Veterinary Series of *The Agricultural Ledger* have been published numerous papers on the above and other diseases which the reader, desirous of such information, should consult. Two papers may, however, be specially indicated, namely, Dr. K. Mcleod's *Measures, Legal and Sanitary, adopted by European Countries* to oppose the introduction and spread of cattle plague (1896, No. 20), and Prof. Koch's *Method of Immunising Cattle against Rinderpest* and the Resolution of Government of India on the same, together with the Opinions of Indian Veterinary Authorities (1898, No. 5). But for practical dairying operations, particulars of all the ordinary ailments of cattle will be found in the chapter on diseases of horned cattle and their treatment given by Meagher and Vaughan, in their work on *Dairy Farming in India* (1904, 113–143, 147). These authors conclude with the following recommendations, strict attention to which they consider calculated to avert serious loss and inconvenience:—

Prevention of Disease.

"(*a*) Proximity of grazing grounds to the cattle-yard, enabling the cattle to go out and back without possible contact with outside cattle or their tracks ; (*b*) Complete separation between the dry stock and cattle in milk ; (*c*) Frequent inspection of all home cattle, and immediate isolation of animals from any disorder, however simple ; and the prompt disinfection of all ropes, standings, troughs, etc. ; (*d*) Perfect sanitation in and about the cattle-yard, standings, stalls, etc. ; (*e*) Tramway lines for the conveyance of grain, fodder, etc., to the cattle-yard and the rigid exclusion of all outside draught-cattle bringing in these supplies ; (*f*) The allotment to sick cattle of special attendants, who must not be permitted to approach the healthy animals, or associate with the staff working in the cattle-yard ; (*g*) The best and most wholesome fodder, grain, cake, etc., only fed to the cattle ; and (*h*) Complete segregation at as great a distance as possible from the infected enclosure ; and, as calves are the principal medium, not more than sixteen calves should be housed together."

Criminal Poisoning.

Poisoning.—Among the important causes of cattle-death has unfortunately to be given criminal poisoning. The *chumars* are the chief criminals, and their method of accomplishing their nefarious purpose is by the use of the *sui* (see **Abrus**, p. 1).

[*Cf.* Voelcker, *Improv. Ind. Agri.*, 1893, 213–5 ; Pease, *Cattle Plague*, in *Agri. Ledg.*, 1896, No. 8 ; also Kristnasamiengar, *Cattle Disease of Mysore*, 1896, No. 28.]

II. THE GOATS AND SHEEP OF INDIA.

D.E.P., vi., pt. ii., 549–83.

Goats and Sheep.

In addition to the oxen (discussed above) the family of the Bovidæ includes the goats and the sheep :—

THE WILD GOATS.—The following are the species recognised by zoologists :—

Wild Goat.

Capra ægagrus, *Gmelin;* Blanford, *Fa. Br. Ind.* (Mammalia), 502–3 ; Masson, *Journ. to Kalat*, 1843, 445–6 ; the *pasang* (male), *boz* (female), *borz*, *kayik*, *thar*, *sair*, *sarah*, *chank*, etc. A wild goat found throughout Asia Minor Persia, Afghanistan, Baluchistan and Sind.

Origin of Domesticated Goat.

This remarkably interesting goat inhabits barren rocky hills in herds of varying numbers, but always keeps much to the cliffs and crags. Capt. Hutton, who, while Resident at Kandahár, devoted much careful study to ***C. ægagrus*** in domestication, and cross-bred it with the common goat, arrived at an emphatic opinion, opposed to that advanced by Hodgson and others, namely, that the Persian and Afghan goats at all events were not derived from ***C. ægagrus***. The late Dr. Blanford, the most recent author, however, says " there can be no doubt that ***C. ægagrus*** is one of the species, and probably the principal from which tame goats are derived." The flesh of this wild goat is highly prized. The skins are valued as water and flour bags. The horns are carried by mendicants, and trumpeting horns are made of them. The bezoar-stones are found in the stomach (see **Bezoar**, p. 131).

Markhor.

C. falconeri, *Hugel.;* Blanford, *l.c.* 505–8 ; Vigne, *Travels, etc.*, 1842, ii., 279 ; the *markhor* (snake-eater), *ráche* (the great horn), *tush-ra* (water goat), *rezkuh*, *rush*, *pachim*, etc.

Crossed with Domestic Goat.

A magnificent animal which inhabits the Himalayan tracts west of the Beas to Kashmir, Ladakh, Baltistan, Afghanistan, Baluchistan, etc. It frequents high ranges, especially where concealment is afforded by shrubs or broken rocks, and is then met with in large herds. There are several well-marked local varieties that differ from each other mainly in the length, shape and degree of twisting and curving of the horns. It is much sought after by sportsmen, and is said to be in appearance by far the grandest of all the wild goats. Has repeatedly been bred in confinement and crossed with the domestic goat. It is generally believed, in fact, that some of the races of domestic goats with spiral horns have descended from this species. There are two important points that should be borne in mind : the direction of the spiral of the horns is outwards, not inwards (as in most domestic goats), and the *markhor* does not possess the under-fur or *pashm* (*pam*) of the alpine domestic breeds.

Himalayan Ibex.

C. sibirica, *Meyer;* Blanford, *l.c.* 503–5 ; the Himalayan Ibex, the *skin* or *sakin*, *dabmo* or *danmo*, *kail*, *tangrol*, *buz*, *skiu*, etc.

Ibex.
Asali Tús.
Wild *Pashm.*

This ibex may be said, so far as India is concerned, to extend from the eastern limits of the last-mentioned species east to Nepal. On the north of the Himalaya, however, it is very plentiful and passes considerably to west of its more strictly speaking Indian area, so that in Central Asia it can be spoken of as distributed from the Altai to the Himalaya. It frequents the most precipitous cliffs at elevations close to the limits of perpetual snow. Is able to withstand the extreme cold through its possessing a thick under-fur (*pashm* or *pam*). This interesting animal is, in fact, much sought after on account of its under-fur, which in Kashmir is called *asali tús*. Shawls, stockings and gloves are lined with it and the wool is also woven into the remarkably fine cloth called *túsi* or into the famous ibex shawls. Cooper speaks of two specially fine qualities of *pashm*, a white and a grey, both obtained in Tibet from a small species of wild goat called *thosh*. It is said that no wool is so rich or so soft. The hair or upper-coating, on the other hand, is made into ropes or woven into coarse cloth—*pattu*—and used for coats, tents, etc. In Ladakh large numbers of this goat are annually killed in winter, when forced to descend into the valleys. In consequence a fairly extensive supply of wild *pashm* is regularly obtainable. No one has, however, recorded the existence of the ibex in domestication, nor of its having been crossed with the tame goats. Still it is sometimes upheld that the *pashm*-yielding domestic goats of the alpine tracts must have been derived from this or some closely allied extinct species.

Domestic Goat.
Hybrids.

BREEDS OF DOMESTIC GOATS.—Very little is known of the origin of the Indian domestic goats. As just stated, ***C. ægagrus*** is believed to have given an important strain to a large percentage of the breeds. ***C. falconeri*** is viewed as having similarly contributed in building up the peculiarities of some of the breeds with spiral horns. Fossil remains of a closely allied goat have been found in the rocks of the Siwaliks and of possibly another species in Tibet. Crosses between the wild goat of Western Sind and Quetta with the *markhor* have not only been produced but found naturally and shot by sportsmen. The powers of endurance possessed by these animals may be inferred from the circumstance that ***C. ægagrus*** is found near the sea-level in Sind and Baluchistan and at 13,000 feet in Persia. According to Henderson, ***C. sibirica*** bears so strong a resemblance to certain breeds of tame goats, met with on the alpine Himalaya and Tibet, that it may be safely assumed to have given to these their undercoat of *pashm*.

Asiatic Goats Mixed Origin.
Hill Goats.
Shawl-goats.

Thus, then, the authors whose opinions are of most value admit the possibility of the Asiatic goats having been derived from more than one species, and the advisability of such a conclusion (apart from the diversified form, stature, colour, habits, etc., of the tame races) receives countenance from the admitted existence of fertile hybrids between the wild species themselves, as also between these and the domestic animals. The progression in characteristics from the typical village goat of the plains and the *dúgú* goat of the lower Himalaya to the Alpine *pashm*-yielding animal may, therefore, mark the stages of adaptation and crossing of different species, with the nearer approach in the extremes to the specific types. If there be any plausibility in this suggestion, the difficulty which the early writers foresaw in any attempt to breed the true *pashm* goat on the southern slopes of the Himalaya would at once assume a distinct position. Lawrence (*Valley of Kashmir*, 364), speaking on this subject, says, " An attempt was made to introduce the shawl-goat into Kashmir, but it failed, as the climate is not sufficiently severe to induce the undergrowth of wool which nature provides in Tarfán for the protection of goats and other animals from the keen winds of that country." It would thus seem certain that the closer the effort at improvement is kept within special areas and with existing stocks the better. To cross the *pashm* goats with the non-*pashm* breeds

Angora Goat.

of Angora blood, as has been suggested, would obviously be to court failure. It might, however, be possible to cross the alpine breeds of Sind, Baluchistan and Hazara with the Angora goat, if foreign blood be considered essential.

Extend Production of Wool.

Many years ago the proposal was made to establish sheep and goat runs on the southern slopes of the Himalaya with a view to improve and extend the Indian supplies of wool and hair. This has never been definitely tried, though much has been written on the growing necessity for better and more certain supplies of these staples. Falconer seemed to think that the *pashm* goat might be acclimatised on the southern slopes of the Himalaya, but it must not be forgotten that the down of the ibex and of the *pashm* domesticated goat seems to be directly the result of the drier and ever so much colder nature of the northern as compared with the southern slopes. Indeed the *pashm* goat may be said to actually exist at Spiti, and according to Hodgson the *chápú* is the acclimatised form of the Tibetan *chángrá*. If this be so, the goat, even if successfully reared on a more extended scale than at present on the southern slopes, would probably yield a far inferior *pashm* than the northern stock, if indeed it did not degenerate into a form of the *pat*-yielding (not *pashm*) goat. It may, however, be safely said that for present European commerce a *pashm* goat is not an indispensable necessity of success.

Southern Slopes.

Plains Goats.

Speaking of the plains, sheep and goats are most successfully reared in areas that receive a moderate rainfall. Upland well-drained soils with sparse jungle growth and a considerable variety of herbage are necessary. In peninsular India the shepherds possess large flocks, with which they wander from place to place when arable land is usually clear of crops. The sheep and goats graze during the day and are folded at night on land where it is desired to obtain the manure of their droppings. This is paid for by the cultivators whose lands are thus benefited. Goats are valued for their meat and milk, and on the Himalaya for their hair.

[*Cf.* Royle, *Prod. Res. Ind.*, 1840, 161–72 ; Wallace, *India in* 1887, 147 ; Voelcker, *Improv. Ind. Agri.*, 212–3 ; Mollison, *Textbook Ind. Agri.*, ii., 59–62 ; Mukerji, *Handbook Ind. Agri.*, 593–4 ; Watt, *Provisional List Animal Prod.*, 1902, 77 ; Aitken, *Sheep-Feeding*, *Journ. Board Agri.*, Sept. 1901, viii., 155–64.]

Breeds.

CHIEF BREEDS.—With the exception of Mr. B. H. Hodgson's valuable paper on the sheep and goats of the Himalaya and Tibet, and of Capt. T. Hutton's paper on the sheep and goats of Afghanistan, the subject has never been systematically treated, and little can be added to the particulars given already in the *Dictionary*. I am, therefore, unable to do more than mention by name some of the better known breeds of Indian goats :—

South India.

1. **South Indian Goat.**—These are gaunt in appearance and badly proportioned, but hardy and active and can exist on almost any kind of vegetation.

North India.

2. **North Indian Goat.**—A much finer animal than that found in the south. The ears are large and perfectly pendent. This is possibly the *jamnapari* of Hodgson. [*Cf.* Hoey, *Monog. Trade and Manuf. N. Ind.*, 1880, 90, 105–6 : Fim, *Monog. Woollen Fabrics U. Prov.*, 1898, 2–3 ; *Note on Indig. Sheep and Goats of the Pb. in Land Rec. and Agri.*, 1903.]

Gujarat.

3. **Surat and Gujarat Goats.**—These are small short-legged animals that are much valued as milkers.

Nepal.

4. **Nepal Goat.**—The best-known breed ; has long flapping ears and rounded nose.

Bengal.

5. **Bengal Goat.**—This is smaller even than the Madras animal, and is usually quite black and destitute of horns. Hodgson identifies it with the *dúgú* of the Himalaya. [*Cf.* Basu, *Agri. Lohardaga*, 1880, i., 92 ; ii., 44–5 ; Banerjei, *Monog. Woollen Fab. Beng.*, 1899, 1–3, 35–6.]

Hill.

6. The **Hill Goats** of the Deccan, Sind, Rajputana and Baluchistan.—The hair of these animals is more abundant and woolly than the plains goat, and the horns

are often large but only exceptionally spiral. These are the hair-yielding species of India.

Syrian.

7. **Syrian Goat.**—Hybrids of this breed, commonly designated "Aden goats," are well known in India, whither they are imported by the Arab traders and passed off under the names Angora or Kashmir. They have long, flapping, pendent ears and slender limbs. Their horns are usually erect and spiral.

Himalayan Goats.

8. **Himalayan Goats**—Hodgson's paper (*Journ. As. Soc. Beng.*, 1847, xvi., pt. 2, 1003–12), as already stated, practically gives all information regarding those known to exist. He refers them to the following special breeds:—

(*a*) *Chángrá*—the common domestic goat of Tibet, which hardly deviates from the wild goat (***C. ægagrus***) except in the large and pendent ears. Hutton, on the other hand, holds that so far as the Persian and Afghan goats are concerned, they could not be regarded as derived from the wild goat just named.

(*b*) *Chápú* or *Chyápú*—the goat of the Sub-Himalaya (especially the Cis-Himalaya). It is much smaller than the *chángrá* and has long hair and fine sub-fleece.

(*c*) *Sinal* or *Singál*—an inhabitant of the more northern parts of the Sub-Himalaya from Kumaon to Nepal, where it is probably indigenous. The surcoat and fine sub-fleece, though inferior to those of the *chángrá* and *chyápú*, are yet capable of being applied to the manufacture of ropes, blankets, serges, etc. It is less patient of change than the *chángrá* or *chyápú*, but the mutton is good, especially that of the kids.

(*d*) *Dúgú*—a goat of the Central Sub-Himalaya and lower warmer tracts. It is characterised by the absence of the long hair and the nearly as frequent absence of the interdigital pits of the other breeds. The male is much larger than the female, and often almost shaggy. There is no sub-fleece, the hair is coarse and next to useless. [*Cf.* Barnes and Lyall, *Settl. Rept. Kangra*, 1889, 38–43; Diak, *Settl. Rept. Kangra*, 1898, 36–68; Drew, *Jummoo and Kashmir*, 1875, 288; Lawrence, *Valley of Kashmir*, 1895, 360–4.]

Sheep.

THE WILD SHEEP.—It has, however, been known from the most ancient times that wild sheep and goats exist in India. Ælian (compiling from Megasthenes, 300 B.C.) speaks of the wild sheep and goats on the mountains of India. If considerable uncertainty exists as to the origin of the Indian goats, a far greater obscurity enshrouds the sheep. The structural difference between the members of the genus CAPRA—the goats—and that of OVIS—the sheep—is very small indeed, and one species—***Ovis nahura***—is practically intermediate. The origin of the Indian tame sheep is unknown. Continuing the example above, the following are the wild species:—

Origin of Domestic Sheep

Great Sheep of Tibet.

Ovis hodgsoni, *Blyth* (**O. Ammon,** *Hors.*); Blanford, *Fa. Br. Ind.* (Mammalia), 494–5: the Great Sheep of Tibet, the *nyan*, *nyand*, *hyan*, *niar*, etc. This magnificant sheep, probably the largest of the genus, does not usually occur on the Indian side of the Himalaya. It is the shyest and wildest of all animals, and is very hard to kill. It has never been domesticated, but wild hybrids between it and ***O. vignei*** have been shot.

Bharal.

O. nahura, *Gray*. Blanford, *l.c.* 499–501; the Bharal or Blue Wild Sheep, the *bharal*, *bharut*, *na*, *wa*, *nervati*, *nao*, etc. This sheep is met with in the alpine tracts (between the limits of forest and snow) from Bhutan to Ladakh and Western Tibet.

Great Sheep of Pamirs

O. poli, *Blyth*: Blanford, *l.c.* 496–7; the Great Sheep of the Pamirs: Marco Polo's sheep: is the *kuchkár*, *ras*, *rush*, *kulja*, *arkar*, etc. This remarkable sheep only comes within the Indian area at Hunza, north of Gilgit. [*Cf.* Marco Polo, *Travels* (Yule, transl.), i., 163–9.]

Ural.

O. vignei, *Blyth*: Blanford, *l.c.* 497–9: the Ural or Sha—the Bearded Sheep, known to the Natives as the *kuch*, *koch*, *guch*, *gad*, *mish*, *sha*, *ural*, *uriar*, etc. It is the wild sheep of the Salt Range in the Panjáb and of the Suliman Range of Hazara and Afghanistan, etc. The varieties most generally recognised are the *ural*, which occurs between 800 and 5,000 feet, and that called the *sha* at much higher altitudes—10,000 to 14,000 feet.

Hybrids.

It has been bred freely with tame sheep, and wild hybrids (as already noted) between it and ***O. hodgsoni*** have been shot. If, therefore, any of the preceding animals have contributed to the breeds of Indian sheep, ***O. vignei*** seems to have done so. It apparently affords a small proportion of the *pashm* known as *thosh*, and from the lachrymal sinus a thick gummy substance is obtained that is much valued in greasing metal locks. Mr. Drummond informs me that pure or half-breed *dumbas* have been crossed with this wild sheep and that the progeny exhibit, while young, an under-fleece similar to *pashm*. But according to local belief this cross is only attained if *dumba* stock be employed.

Domestic Sheep.

South-Indian Breeds.

Hair rather than Wool.

Breeds of Domestic Sheep.—Sheep are met with throughout the plains and lower hills of India and up the Himalaya to the sub-arctic zones. The breeds of Indian sheep are quite as extensive and diversified as those of Europe. Some are tropical, thriving in swampy regions or on dry, arid tracts, others warm temperate, still others temperate or even arctic. There has, however, been even less of an authoritative character written of the Indian sheep than of the goats. Most writers have discussed the Patna, Dumba, Meywar, Madras, Mysore, etc., breeds without having considered it necessary to detail their characteristic features. Shortt (*Manual of Indian Cattle and Sheep*), if his illustrations can be viewed seriously, would seem to establish for South India certain well-marked breeds, and doubtless extensive diversities exist among the sheep of other provinces. But, speaking generally, it may be said of perhaps more than half the breeds found on the plains of India, that they afford a kind of hair rather than a wool. They are reared chiefly on account of mutton, their fleece, like the hair of the village goat, being, comparatively speaking, valueless.

Woolly Sheep.

Dumba Sheep.

Fat Tail.

Chief Wool-bearing Sheep.

But although many of the sheep of India yield a fleece of hair rather than of wool, certain breeds give fairly good wool. Of this class may be mentioned the black-headed sheep of Coimbatore, the woolly sheep of Mysore, the sheep of large portions of the Deccan, of Rajputana, of the Panjáb, and, in Bengal and the United Provinces, the so-called Patna sheep. Although there are possibly several very distinct breeds of large fat-tailed sheep (all designated *dumba*), these should be classed as wool-yielding breeds. They have been crossed with the Patna, the Merino and other imported sheep, and apparently with satisfactory results, though the improvement effected cannot be said to have been lasting. Some of the fine wools imported from Afghanistan and Persia are obtained from breeds of *dumba* sheep, and this fact having been ascertained many years ago, effort was put forth to secure stock for breeding purposes. So far the result, however, has been unsatisfactory, for when conveyed to the moister tracts of India, the fat tail has proved a source of danger. It is liable to disease, so that unless a breed could be produced, in the natural habitat of this animal, that would preserve its merit as a wool-producer during successive crosses in which it was gradually developed into a condition suitable to the plains of India generally, it is not likely to be of much value to future breeders. It may, in fact, be said in conclusion that, so far as past experience goes, the breeds of most value, as Indian stock for improvement, are the Coimbatore, Mysore, Rajputana and Patna. But it may be added that perhaps the majority of persons who have given this subject anything like careful consideration seem to incline to the view that except in certain tracts, there is very little hope of India as a whole becoming of much greater moment than at present as a country of wool-supply. Interest is far more keenly directed towards facilitating importation from the mountainous countries bordering on India, than in any material improvement of the wools of the plains. [*Cf.* Orrah, *Wool of Baluch. and the Introd. of Merino Sheep and Angora Goats*, March 1890.]

Chief Breeds.

The following may be mentioned as the better known breeds of sheep in India:—

Rajputana. Tuttyghar.

1. **Rajputana (Meywar) Sheep.**—These are the finest and largest sheep in India. They are sometimes called Delhi-Hansi or Tuttyghar sheep. They have poor wool, but the mutton is large though somewhat coarse. [*Cf. Ann. Rept. Civil Vet. Dept.*, 1893-4, 14-6.]

2. **Bengal and Patna Sheep.**—The former is very inferior but the latter one of the best breeds in India. They yield good wool and fatten readily. In 1836 an effort was made to improve the Patna sheep by crossing them with Southdown rams. So also a similar effort was made with Bhagalpur sheep.

Madras.

3. **Madras Sheep**—The best are those of Chingleput, Kistna, Godavari, Ganjam, Arcot, Salem, Trichinopoly, Tanjore, Madura and Tinnevelly. They are coated with a coarse brown wool or hair of little value. An experiment was for some years prosecuted at Heraganhalli to improve these sheep by crossing them with Merino rams imported from Australia. This was abandoned in 1863.

Nellore.

4. **Nellore Sheep.**—A large breed, examples of which have been known to scale 80 to 100 lb. They are tall, leggy, and white or light brown in colour.

Coimbatore.

5. **Coimbatore Sheep**—This is known as the *kurumba* breed. It is a wool-producing animal, small in size, the prevailing colours being black with white heads. They fatten well, and the mutton of gram-fed animals is rich and well-tasted.

Mysore.

6. **Mysore.**—This is a woolly breed. The prevailing colour is light to a very dark grey or black. It furnishes the best fighting rams of the plains. [*Cf.* Buchanan-Hamilton, *Journ. Mysore, etc.*, 1807, i., 119-21: ii., 276-8; iii., 354-5.]

Bombay.

Breeding Experiments.

7. **Bombay Sheep**—Dr. Hove, in 1787, speaks of the sheep in the Deccan as being the finest he had seen in India and as having superior wool. So long ago as 1835 Col. Jervis conducted extensive experiments with a view to improving the Bombay sheep. Subsequently Col. Pottinger, Sir A. Burnes and others brought sheep from Kabul, the districts of the Upper Indus, Persia, the Cape of Good Hope and England. A farm was established at Ahmednagar, and for some years vigorous experiments at stock improvement were prosecuted. This was reported on by Sir George Arthur in 1843, who recommended that fresh Merino rams should be continuously imported for some years to come. The subject seems, however, to have been suddenly forgotten and the farm abandoned, for nothing of any importance was subsequently published regarding it. Mollison (*Textbook Ind. Agri.*, ii., 59) says nothing of these experiments nor of the fate of the farm. He offers, however, many useful and practical suggestions based chiefly on experience gained in Bombay. Sheep and goats, he says, are most successfully bred in districts with moderate or light rainfall and light, naturally well-drained soils. Neither sheep nor goats thrive during the monsoon in heavy-soil districts. In the breeding districts large flocks do not thrive unless they are continuously grazed on clean ground. Large flocks of sheep and goats are brought in the fair season by professional shepherds from Kathiawar into the plains of Northern Gujarat, and also from the upland comparatively dry waste grazing lands east and north of Khandesh, to the black-soil tracts and arable plains of the Deccan. A few goats among the sheep are decidedly advantageous. They lead the flock and keep the sheep moving and thus grazing. [*Cf.* Morgan, *Sheep-Breeding in the Deccan*, in *Agri. Ledg.*, 1895, No. 18.]

Light Rainfall and Light Soils Essential.

Nepal.

8. **Nepal Sheep.**—Of these there are two kinds—the village *ghorpalla* and the forest *ran baria*. The last is a small and almost semi-wild animal that lives in large flocks on the wooded hill slopes.

Kashmir.

9. **Kashmir Sheep.**—Lawrence (*Valley of Kashmir*, 360-4) gives many interesting particulars regarding the sheep and wool of Kashmir, but says nothing of the breeds met with except that some are as good as the Southdowns. Mr. Drummond informs me that in Kashmir it is the custom to wash the sheep in the river before being shorn, a circumstance that would point to the wool being valued more highly than is commonly believed. Baldrey (*Agri. Journ. Ind.*, 1906, i., pt. iii., 201-4) urges the "Benefits of Sheep-dipping" in India.

Himalayan and Tibetan.

10. **Himalayan and Tibetan Sheep**—Hodgson mentions some five breeds with, under some of these, several sub-breeds. Space cannot be afforded to do much more than enumerate the principal examples of these by name:—

Húniá.

(*a*) *Húniá* of Western and *Hálúk* of Eastern Tibet. A tall, graceful animal, the universal beast of burden on the higher snowy ranges—is docile and sure-footed. Hodgson compares this with the great wild sheep (**O. hodgsoni**). It cannot endure the rank pasture or high temperature of the Sub-Himalaya. Mutton and fleece are both excellent.

Siling.

(*b*) *Silingia* or *Siling* sheep or *Pelúk* of the Eastern Himalaya. According to Hodgson, the Siling country corresponds to the *Serica regio* of the classics. The animal is smaller than the *húniá*. In colour it is white tinged with fawn.

Barúal

(*c*) *Bárúal* or *Barwal* is a Cis-Himalayan breed and the ordinary sheep of the Cachar or northern regions of the Sub-Himalaya between the Júmla and the Kirant. Hodgson, in fact, says this breed practically extends from Kumaon to Sikkim. It is the great fighting ram of the hill tribes. It is remarkable for its massive horns entirely covering the top of the head. The flesh and the fleece are both abundant but coarse. By far the largest number of the *rúhris* or coarse blankets and serges manufactured in these hills, and which are extensively exported therefrom, are made of *bárúal* wool. Coarse as this wool is, it is, however, superior to the wool of the plains.

Coarse Blankets.

Cágea.

(*d*) *Cágéa*—This is the characteristic breed of the central region of the Sub-Himalaya. It is reared rather by householders than shepherds, and for its flesh rather than its wool. It is a handsome animal, but its head is too large, though the legs are short.

(*e*) The *Terai* Sheep. This is practically identical with the sheep of the plains.

It may in conclusion be pointed out that Hodgson's Trans-Himalayan sheep (the *húniá* and the *silingia*) are, like his Trans-Himalayan goats (*chángrá* and *chápú*), far superior to his Cis-Himalayan breeds. If, therefore, India cannot acclimatise and develop new breeds on the southern slopes of the Himalaya, attention should be given to increased facilities of transport and more friendly intercourse with the Trans-frontier tribes for increased supplies of superior wool.

Improved
Transport.

Dumba.

11. **Hira and Dumba Sheep.**—Some at least of the breed are natives of Afghanistan and Persia, and others of Africa. They are frequently imported into India, and are large sheep characterised by the immense development of masses of fat placed on either side of the tail, forming stores of nourishment which are drawn upon during the winter months, when fodder is scanty. Hutton tells us that in some parts of the country the tail grows, in fact, to such a size that a small wheeled carriage has often to be constructed to carry its weight. Hodgson calls them *púchia* (tailed) sheep. The wool is of good quality, and on that account they have often been crossed with Indian plains sheep. Mollison says *dumba* sheep have proved exceptionally suitable for crossing with the Deccani stock. The wool of these half-breeds, like that of the pure *dumba*, is of fine quality and long. The mutton is said to be coarse, though the tail is sometimes spoken of as of great value.

Tail Carriage.

Ælian (*De Nat. Hist. Anim.*, 250 A.D., iv., 32) speaks of the tails of the Indian sheep reaching to their feet and as being cut open by the shepherds, the tallow removed, and the tails sewn up again. Marco Polo, in the 13th century, and Varthéma, in the 16th, describe the *dumba* or Ethiopian sheep as seen by them on the east coast of Africa. Marco Polo says the tail often weighs 30 lb., but Varthéma puts it at a lower figure, 15 to 16 lb. Terry (*Voy. E. Ind.*, 1622 (ed. 1777), 90) observes that "their sheep differ from ours by their great fleshy bob-tails which severed from their bodies are very ponderous. Their wool is generally coarse but their flesh is not so." There would thus seem no doubt that this particular sheep has existed in India from fairly remote times. The head and neck are quite black and the body otherwise white. In the Cairo Museum, among the ornaments found in the mummy-pits, there is a little figure of one of these sheep, so that it may safely be said they have been known from ancient times and beyond the limits of India. [*Cf.* Cordemoy, *Le Prod. Colon. d'Origine Animale*, Paris, 1903, 126–38.]

Ethiopian.

III. HORSES, ASSES, AND MULES OF INDIA.

**D.E.P.,
iv., 289–99.
Horses,
Asses, etc.**

The horse has been a domesticated animal since prehistoric times. Ælian, compiling doubtless from Megasthenes, 300 B.C. (*De Nat. Hist. Anim.*, xvi., 2–22), says, "In India there are herds of wild horses and also of wild asses." No aboriginal or truly wild horse is known to exist to-day, though wild representatives of the ass are well known. [*Cf.* Blanford, *Fa. Br. Ind.* (Mammalia), 470–1.] There seems, however, little doubt that all the existing races and breeds of horses have descended from one common stock, which Darwin believed was dun-coloured and more or less striped. In Neolithic times a wild horse would appear to have existed in Europe, but the animals of the present time have probably not been developed from these, but from animals which it is well known were imported from Asia into Greece and Italy. But even these Asiatic ancestors were doubtless only a consequence of a still earlier long-continued selection from a stock or stocks that to some extent may be indicated by the fossil remains discovered. The artificial selection conducted by man has been toward specific purposes. The English thoroughbred may be mentioned as the final manifestation in speed; the English draught-horse in working capacity; and the Shetland pony in sure-footedness and suitability for mountainous regions. What may be true of England can be shown as equally applicable to all countries wherever the horse has been appreciated in agricultural, industrial and political life. The most ancient histories and traditions of India point to a specialisation in warfare. Ælian describes the King's stables; the use of the bit and bridle in making the horses move at a measured pace; the breaking in of the animals by forcing them to gallop round and round in a ring; and when on the march, we are told the war chariots were drawn by oxen and the horses led on a halter so that their legs might not be galled nor their spirits damped by drawing the chariot to the battle-field. None of the early writers would seem to make even the most distant allusion to the Indian horse being used for agricultural purposes or for transport; adaptation, therefore, to riding and swiftness were the directions of early Hindu influence on the horse. The establishment of the rule of peace under British supremacy of necessity meant the overthrow of martial power and the loss of the races of fiery chargers that doubtless previously existed in India.

Special Selection.

Bit and Bridle.

Early Hindu Influence.

Indian Breeds.

Principal Indian Breeds.—There seems at all events little doubt that the Native breeds of horses have diminished and deteriorated since the establishment of British rule in India. The suppression of the predatory system lessened the demand, and the superior Lakhi and Cutch breeds which for centuries had been famous became almost, if not altogether, extinct. It is probable also that the requirements of modern warfare for larger and more powerful animals than India naturally produced, led to a system of artificial breeding, in which size was the object mainly aimed at, an object that might easily have resulted in the deterioration of the original small, hardy and swift breeds and the production of badly formed and weedy animals. Within recent years the Government of India have adopted, in the Civil Veterinary Department, a policy of supplying specially selected stallions to each important centre. These have been chosen in consideration of the most hopeful directions of improvement of existing stock, and their services are placed at the disposal of horse-breeders free of charge, provided the mares have been examined, approved and branded, by a representative of the Department. According to universal repute this has had a most beneficial effect. The following are some of the better known indigenous breeds:—

Direct Adaptation.

Improvement Assured.

Kathiawar.

1. **Kathiawar and Rajputana.**—The Chiefs in these States still continue to give attention to horse-breeding and many of them keep up very large stables, in which the most careful selection is observed. The original breed—known as the Kathi—was noted for its great powers of endurance. The peculiarities of the animal are that it is generally under-sized and small-boned and has a distinctive mark, a black cross down the back and black bars on the legs, the colour of the

coat varying in every shade of dun. It is supposed to possess a strong strain of Arab blood, an opinion supported by the known frequent intercourse between the two countries. The mares are most esteemed, as the horses are noted screamers. The Bhavnagar and Palitana Princes take the greatest possible interest in the preservation and improvement of this peculiar and special breed.

Kach.

2. **Bombay.**—The horses of Kach and Sind do not materially differ from those of Kathiawar. They are usually a little over fourteen hands, are well made, spirited, showy in action, with clean limbs, good bone, thin long neck, large head, outstanding ram-like brow, and small ears. Their great defect is their bad temper. But there may be said to be three other types in the Presidency in the hardy Maratha pony, the little Gujarati, and the Bimthadi of the Deccan. The last mentioned is one of the best breeds in India.

Maratha.
Bimthadi.

Baluchi.

3. **Waziri and Baluchi.**—A fine breed of hardy and active animals. They have good shoulders, very deep and moderately broad chests and angular drooping quarters, very broad across the hips. They make excellent troopers on account of their speed and endurance, and, crossed with Arabs and thoroughbred English horses, become good cavalry remounts.

Panjábi.

4. **Panjáb.**—There are many special races, such as those reared about Rawalpindi, Jhelam, Gujrat, Gugaira and Lahore. In the Sikh times the greatest care was bestowed on them, and stallions from Kathiawar, Kach, Baluchistan and Afghanistan were regularly imported and used to improve the stock. The average Panjábi country-bred to-day is small, but possesses great powers of endurance. It used to be a by no means uncommon occurrence to hear of an *ekka* pony dragging a cart and three passengers from Simla to Kalka, thus covering 58 miles in one day, without, as the saying goes, " turning a hair." This is representative of the hardy little animals found on the plains adjoining the North-West Himalaya. In former times the Sikh cavalry were horsed from Dhanni, north of the Salt Range, and even now large numbers of remounts are drawn from that country.

Dhanni Horses.

Burma and Manipuri.

5. **Burma and Manipur.**—The ponies of Burma, which are small, hardy and exceedingly tractable, are said to be all importations from the Shan States and Manipur. Their characteristic pace is an unbroken run, in which the shoulders seem to roll from side to side. The pure Manipur is generally considered the best of all Indian ponies. It is well under thirteen hands, is mostly dun-coloured, and is possessed of wonderful powers of endurance and weight-carrying capabilities.

Himalayan.
Ghunt.

6. **Himalayan Ponies.**—The *Ghunt* or *Khund* breed is met with in Lahoul and Spiti, and is employed almost entirely for saddle purposes. It is never over twelve hands, is strongly built, exceptionally surefooted and hardy, but is often very hard-mouthed and stubborn. A similar animal is the Bhutia pony, which often attains a height of fourteen hands. A larger and more valuable breed is that known as the Yarkand pony. It much resembles the *Yábú* of Afghanistan; has a short round body, deep chest, full quarters, and thick limbs—a miniature English cart-horse. It is an admirable pack-horse, and inured to heavy loads. It moves at about five miles an hour, and if allowed to preserve that pace has great powers of endurance. Closely allied is the pack and riding pony of Baltistan and Kashmir.

Bhutia.
Yábu.

Asses and Mules.

7. **Asses and Mules.**—The ass exists in all parts of India and is largely used as a beast of burden, especially by the *dhobis* or washermen, potters, tinkers, etc. As a rule it is badly cared for, its only redeeming feature being its cheapness. In Kathiawar there is a specially good breed of donkeys, of which the Halar or Jhalavad white variety is specially deserving of notice. The people of the interior Himalaya have also a peculiar breed—a very small black animal with long shaggy hair. This they bring with them when they come down in the winter months to seek work at Simla and other outer hill stations. Mules seem to have been known from the most ancient times in India. Ælian says that the mares are often covered by the wild asses, red-coloured mules being the result. These are very fleet and impatient of the yoke. They are caught with foot-traps, and when only two years old may be tamed and domesticated. They are then taken to the King of Persia. Blanford gives full particulars of the Asiatic Wild Ass. It is found throughout Central and Western Asia, a few being occasionally seen in Baluchistan, the Panjáb frontier, and even east of the Indus in Bikanir and the Rann of Kach.

Halar.
Himalayan.
Mules.
Wild Ass.

Donkeys.

For many years past the Government of India have made strenuous efforts to improve the breed of the plains donkeys, and to secure the rearing of a good quality of mules. They have accordingly supplied donkey stallions and offered rewards and prizes for good mules. The Natives of India have, in many localities, a semi-religious objection to breeding mules. [*Cf. Ain-i-Akbari,* 1590 (Blochmann, transl.), 132, 152; Linschoten, *Voy. E. Ind.*, 1598, i., 54; Terry, *Voy. E. Ind.*, 1622 (ed. 1777), 132–4; Barbosa, *Coasts E. Africa and Malabar* (ed. Hakl. Soc.), 49, 76–7, 89–90; Mandelslo, *Travels Ind.*, 1662, 35, 86; Ovington, *Voy. Suratt*, 1689, 253; Tavernier, *Travels Ind.* (ed. Ball.), i., 102, 283; ii., 263; Hove, *Tours in Gujarat, etc.*, 1787, 53, 67; Montgomery Martin, *Hist. E. Ind.*, ii., 425; Honigberger, *Thirty-five Years in E. Ind.*, i., 72; Wilson, *Cutch Horses*, in *Journ. Roy. As. Soc.*, vii., 141; Macgregor, *Journ. to Khorasan*, 1875, 292–4; Wallace, *India in* 1887, 127, 141; Hoey, *Monog. Trade and Manuf. N. Ind.*, 58, 102; Voelcker, *Improv. Ind. Agri.*, 211–2; Lawrence, *Valley of Kashmir*, 364–5; *Agri. Ledg.*, 1893, No. 19; 1894, No. 12; 1896, No. 3; *Govt. of Ind. Resolution*, 1896; *Journ. Nat. Hist. Calc.*, vii., 469; *Ann. Repts. Civ. Vet. Dept. in Ind. since* 1895–6; Ewart, *The Penycuik Exper.*, 1899; Mollison, *Textbook Ind. Agri.*, 1901, ii., 10–1, 41–8; Pierre and Monteil, *Le Cheval au Soudan*, in *L'Agri. Prat. des Pays Chauds*, 1905, v., pt. i., 126–39.]

D.E.P., iv., 253-4. Pigs.

IV. THE DOMESTICATED PIGS AND WILD BOARS OF INDIA.

Pig or Hog is the name applied to different animals of the family SUIDÆ, the only representative in India of the sub-division of the Ungulates known as *Suina*. Blanford enumerates the following species :—

Indian Pigs.

Sus cristatus, *Wagner*; Blanford, *Fa. Br. Ind.* (Mammalia), 560–2; INDIAN WILD BOAR, *sur, bad janwar, varaha, paddi, dukkar, pandi handi, tan-wet,* etc. This is the only species of any interest or importance economically. It is found throughout India, from the sea-level to an altitude of about 12,000 feet, wherever there is sufficient shelter, either of long grass, low jungle or forest. When abundant it does great damage to crops. The tame pig of India is probably derived from the wild animal, and in some places is said to breed with the latter. Several races of domesticated pigs are met with in India, where religious and caste beliefs allow of their being kept. In the article on **Lard** (pp. 701-2) it will be seen that two chief classes of pigs are spoken of, namely the "China pig" and "the Country pig."

"China Pig." "Country Pig."

S. andamanensis, *Blyth*; Blanford, *l.c.* 562–3. The Andaman Pig. A small animal, some 20 inches high, occurring in the forests of the Andaman Islands.

S. salvanius, *Hodgs.*; Blanford, *l.c.* 563. The Pigmy Hog. In the forests at the base of the Himalaya in Nepal, Sikkim and Bhutan. Its habits are very similar to those of **S. cristatus.** It is found chiefly in high jungle grass, in herds of five to twenty. They are rarely seen, as they leave the forests at night only, but may be traced to their lairs by the mud coatings of the lower vegetation left behind them. In Manipur I found this species to form coverings over their lairs by breaking and throwing down the spiny bamboo.

The pig affords various economic products, the chief of which are Bristles, Lard, Meat (Pork, Ham, etc.) and Skin. LARD is separately dealt with under that heading (pp. 701-3). PIG-SKIN forms, when tanned, a leather which is principally valued for saddlery. That of the wild boar is much thicker than that of the domesticated animal, and consequently offers more difficulty in the process of tanning and preparation. It is also used in the manufacture of many small articles of leather-ware, such as purses, coverings of pocket-books, etc.

Pig-skin.

Bristles.

Bristles are employed chiefly in the manufacture of brushes, and the export trade in bristles and other brush fibres in recent years is very considerable. For the period 1900–7, the following were the EXPORTS of bristles and fibres for broom and brush manufacture :—1900–1, 49,682 cwt., valued at Rs. 14,93,685; 1901–2, 48,488 cwt., Rs. 13,65,600; 1902–3, 70,917 cwt., Rs. 15,79,002; 1903–4, 83,258 cwt., Rs. 20,76,331; 1904–5, 81,290 cwt., Rs. 18,39,854; 1905–6, 93,873 cwt., Rs. 21,51,028; 1906–7, 88,158 cwt., Rs. 17,68,930. Of the total for 1905–6, Madras exported 89,978 cwt. and Bengal 3,604 cwt., and the countries to which the largest quantities went were—the United Kingdom, 30,485 cwt.; Germany, 27,874 cwt.; Belgium, 24,463, cwt.; Ceylon, 5,536 cwt. The IMPORTS are compara-

Exports

Imports.

tively insignificant, averaging for 1900–7 about 450 cwt. In 1904–5 they reached 1,099 cwt., valued at Rs. 29,856; in 1905–6, 697 cwt., Rs. 17,462; and in 1906–7, 599 cwt., Rs. 25,219. Mostly from the United Kingdom and Germany.

Bacon and Ham.

Of ***Bacon*** and ***Ham*** India annually imports large quantities, and the exports are small. The IMPORTS for 1900–7 were as follows:—1900–1, 1,144,716 lb., valued at Rs. 7,61,782; 1901–2, 1,136,959 lb., Rs. 7,47,093; 1902–3, 1,231,934 lb., Rs. 8,16,613; 1903–4, 1,267,724 lb., Rs. 8,16,223; 1904–5, 1,373,474 lb., Rs. 8,09,678; 1905–6, 1,600,898 lb., Rs. 9,40,140; 1906–7, 1,487,729 lb., Rs. 9,52,715. Almost the whole comes from the United Kingdom, viz. 1,575,838 lb. in 1905–6, while small quantities are drawn from Hongkong, Australia, the Straits Settlements, Germany, and Sweden. The EXPORTS of Indian hams amounted in 1904–5 to 672 lb., valued at Rs. 150, and in 1906–7 to 259 lb., valued at Rs. 150. The re-exports in 1904–5 were 7,323 lb., valued at Rs. 4,358, but in 1906–7 only 537 lb. Thus, adding together all the available returns of the products derived from the pig, the exports in 1905–6 were Rs. 21,69,778 and the imports Rs. 10,17,138; and in 1906-7, exports Rs. 17,84,827 and imports Rs. 10,70,304. The decline in the exports of lard and increase in the imports point to a serious defect, and the large demand for foreign ham and bacon is significant. There are thus great possibilities in the future.

Total Trade.

TRADE IN INDIAN LIVE STOCK.

Trade.

Of the estimated number of animals of all sorts (220 million in 1904–5), about 23 per cent. are annually exported in the form of hides and skins.

Trans-frontier Traffic.

But India imports and exports live stock, and by sea as well as across her land frontiers. Hence the returns under these headings have to be taken into account. It may be desirable to set forth the Trans-frontier trade before exhibiting the foreign. In the official statistics the imports are referred to the following groups—(*a*) Horses, Ponies, Mules: (*b*) Cattle: (*c*) Sheep and Goats: and (*d*) Other Kinds. The totals for the year 1904–5 were 665,024 animals, valued at Rs. 74,74,928; for 1905–6, 685,732 animals, Rs. 65,30,041; for 1906–7, 714,368 animals, Rs. 70,12,607. The most important are the cattle, 105,726, valued at Rs. 44,04,266 in 1906–7: the sheep and goats, 166,653, valued at Rs. 6,12,062: and other kinds of animals 434,704, valued at Rs. 13,14,543. The chief countries of supply of cattle are Nepal, North Siam, and the Southern Shan States. For sheep and goats, Northern and Eastern Afghanistan, Nepal and Kashmir. Of the other kinds, Nepal, South Siam and North Siam. The Trans-frontier exports from British India are less important and need hardly be reviewed. The totals in 1906–7 were 92,644 animals, valued at Rs. 11,78,866. Perhaps the most remarkable feature of the trade recorded as carried by rail and river is the fact that Bengal is the chief exporting province and the United Provinces the principal importing area. The next most important receiving centres are Calcutta and Bombay.

Imports, Cattle.

Sheep and Goats.

Exports.

Imports of Horses.

Turning now to the transactions by sea, the IMPORTS are most valuable under the heading of horses. The total imports in 1903–4 were valued at Rs. 53,62,833, of which Rs. 52,48,590 represented the horses brought mostly from Australia into Bombay and Calcutta; in 1904–5, Rs. 59,27,625 (horses, Rs. 55,47,939); in 1905-6, Rs. 49,41,452 (horses, Rs. 46,76,055); in 1906–7, Rs. 46,55,792 (horses, Rs. 44,88,933). Of the EXPORTS it may be said the position is reversed, the traffic in horses being the least important. The total for 1903–4 was returned at

Rs. 22,27,523, of which Rs. 21,23,214 represented cattle, sheep and goats, etc.; 1904-5, Rs. 19,40,129 (Rs. 18,98,380 cattle, sheep, etc.); 1905-6, Rs. 19,33,828 (Rs. 19,07,228 cattle, sheep, etc.); and 1906-7, Rs. 22,63,176 (Rs. 22,21,416 cattle, sheep, etc. The horses go mainly from Bengal and Bombay to Ceylon and Mauritius, and of the others Madras practically conducts the entire trade, sending the animals to Ceylon and the Straits Settlements.

Fodder. Exports. Rice Bran.

CATTLE FOOD AND FODDER.—Exports.—It is somewhat surprising to discover in the published returns of the foreign trade of India, a heading "Fodder, Bran, and Cattle Food, including Hay and Straw." This is referred to three groups, as follows—Oil-cake: Rice bran: Other sorts. The total exports under these three headings were in 1900-1 valued at Rs. 70,13,826; in 1902-3, Rs. 85,73,627; in 1904-5, Rs. 97,21,116; in 1905-6, Rs. 1,18,15,434; and in 1906-7 at Rs. 93,99,644 (£626,642). Of the large amount for 1905-6, Rs. 51,99,194 represented the value of oil-cake, and Rs. 55,41,825 that of rice bran. Practically the whole of the RICE BRAN goes from Burma and the OIL-CAKE very largely from Madras, with a fair amount from Calcutta and the balance, very nearly, from Bombay. Fully a third of these articles of cattle food is consigned to the United Kingdom; another third to Ceylon, the Straits Settlements and Germany in approximately equal quantities. The balance goes to Java, the Philippines and East Africa, followed by France, Aden, Hongkong, Belgium, etc.

Beef and Mutton.

Prices of Beef and Mutton.—Particulars are given in *Prices and Wages in India* (1904) of beef and mutton in certain localities of Western India since 1855. During that time they have practically remained stationary: if anything, cheapened. Taking the average of the quinquennial period 1871-5 as a standard, the price in the Presidency for BEEF was ·25 rupee a seer (= 2 lb.); in Sind ·17; in Rajputana and Central India ·16. For MUTTON, Bombay ·31; Sind ·18; Central India and Rajputana ·21. Taking these as 100, BEEF in Bombay was (in 1903) 80; in Sind 118, and in Central India and Rajputana 50; MUTTON similarly was 100 (during 1871-5) in Bombay, and in 1903 it was 97; in Sind 144, and in Central India and Rajputana 95. These results are doubtless fairly expressive of India as a whole; but no other returns are available, so that particulars of the other provinces cannot be furnished.

For trade in **Lard and Tallow**, see the separate article (pp. 701-3); **Hides and Skins** (pp. 632-40); and **Oils** (pp. 813-4, 819).

D.E.P., vi., pt. ii., 549-83.

[*Cf. Institutes of Manu*, ii., 41; v., 8; viii., 298; xi., 139; Varthéma, *Travels* (ed. Hakl. Soc.), 1510, 87, 200; *Ain-i-Akbari*, 1590 (Blochmann, transl.), i., 63; (Jarrett, transl.) ii., 350; Linschoten, *Voy. E. Ind.*, 1598, i., 25; ii., 10; Fryer, *New Acc. E. Ind. and Pers.*, 1675, iii., 118, etc., etc.; Ainslie, *Mat. Med.*, i., 156, 184, 221, 423-5; Moorcroft, *Travels*, i., 58-9; Royle, *Prod. Res. Ind.*, 161; Baden-Powell, *Pb. Manuf.*, 49; Lewin, *Wild Races S.E. Ind.*, 1870, 261; *Ind. For.*, x., 339; xv., 27; *Season and Crop Repts.*]

D.E.P., v., 94-7.

LUFFA, *Cav.*: *Fl. Br. Ind.*, ii., 614-6; Duthie, *Fl. Upper Gang. Plain*, 1903, 367; Cooke, *Fl. Pres. Bomb.*, 1903, i., 531-3; Prain, *Beng. Plants*, 1903, i., 519-20; CUCURBITACEÆ. A genus of climbing plants, native of the warmer regions of the Old World and one indigenous in America. Four or five are wild in India.

L. acutangula, *Roxb*; Duthie and Fuller, *Field and Garden Crops*, 1883, ii., 60, t. lxii; *Rec. Bot. Surv. Ind.*, iii., 61, 216. *The taroi* (*torai*), *jhingá, satpatiya, shirálá,* *pikunkai*, etc. A little branched climber, met with in North-West India, Sikkim, Assam and Eastern Bengal.

Cultivation.
Seasons.

Is cultivated in most parts of India for its fruit. Rich soil should be selected, and the seed sown from March to June in lines 5 feet apart. When the young plants are about 4 inches high, supports are required. Until the rains begin, the first sowings have to be regularly watered. The fruit is highly esteemed by Natives and eaten either in curries or dressed with clarified butter. When fully developed it is about a foot long, but if allowed to grow longer than 4 inches it rapidly deteriorates. The seeds possess emetic and purgative properties and also yield an oil. The fibrous texture of the fruit forms, like that of **L. ægyptiaca**, a cheap and efficient flesh-brush. [*Cf.* Gollan, *Ind. Veg. Gard.*, 1892, 117–8; Banerjei, *Agri. Cuttack*, 1893, 117–8; Woodrow, *Gard. in Ind.*, 1899, 333–4; Firminger, *Man. Gard. Ind.* (ed. Cameron), 1904, 168.]

Bath-sponge.

Var. amara; *L. amara*, *Roxb.*; Prain, *l.c.*; *Rec. Bot. Surv. Ind.*, iii., 216; *karuí-taroí, ghosha-latá, títa-jhingá, ránturai, kadú-sirola, adavi-bíra*, etc. Met with all over India, especially on the western side. The fruit is largely used in Native medicine. The juice of the roasted fruit is applied to the temples to cure headache, and the ripe seeds are generally said to be a sure and safe emetic. [*Cf. Pharmacog. Ind.*, 1891, ii. 80–1.]

L. ægyptiaca, *Mill.*; Duthie and Fuller, *l.c.* 61, t. lxiii; *Rec. Bot. Surv. Ind.*, iii., 60, 216. The *ghia-taroi, dhundul, bhol, liasada, dilpasand, ghosálé, gutti bíra*, etc. A large climber common everywhere and often cultivated, especially in the plains. The fruit is edible, and when dried forms a structure of interlacing fibres, used as a flesh-brush in the Turkish bath or as a substitute for the bath sponge, and has more recently been made into boot-socks. The seeds are emetic and cathartic and yield an oil. [*Cf.* Dodge, *Useful Fibre Plants of the World*, 1897, 229; Woodrow, *l.c.* 333–4.]

Boot-socks.

L. echinata, *Roxb.*; *bindaal, janthorí, kukad-vel*, etc. A small climber, native of Gujarat, Sind and Bengal (Purneah and Dacca). The fruits ripen in the cold weather and are medicinal, as is also the stem. It is a bitter tonic and powerful diuretic. [*Cf. Pharmacog. Ind.*, 1891, ii., 81–6; Sen, *Orig. Res. in Treatment of Trop. Diseases*, 1902, 95–8.]

M

MALACHRA CAPITATA, *Linn.*: *Fl. Br. Ind.*, i., 329; Cooke, *Fl. Pres. Bomb.*, 1903, i., 99; Duthie, *Fl. Upper Gang. Plain*, 1903, 84; MALVACEÆ. *The kan (ban)-bhendi.*

D.E.P., v., 109–13.

An erect annual, native of West Tropical Africa and of Tropical America; introduced into India and now plentiful throughout the hotter damp tracts from the United Provinces to the Karnátak. It yields an excellent fibre, 8 to 9 feet long, which experts have decided is little if at all inferior to jute. It was at one time hoped that Bombay through the cultivation of this plant might secure a good and profitable substitute for Bengal Jute. These expectations have never been realised, but the plant in some parts of the Presidency has become so abundant as to be often viewed as indigenous. [*Cf. Offic. Correspond. on Exper. Cult. in Bomb.*, 1878–82; *Agri. Ledg.*, 1896, No. 6, 30; Dodge, *Useful Fibre Plants of the World*, 233; Woodrow, *Gard. in Ind.*, 1899, 184; *Imp. Inst. Tech. Repts.*, 1903, 69.]

Jute Substitute.

MALLOTUS PHILIPPINENSIS, *Muell. Arg.*; *Fl. Br. Ind.*, v., 442; Gamble, *Man. Ind. Timbs.*, 1902, 619–20; Talbot, *List Trees, etc.*, 1902, 316; Hooper, *Agri. Ledg.*, 1905, No. 4; also *Rept. Labor. Ind. Mus.* (Indust. Sec.), 1905–6, 30, 33–4; *Rec. Bot. Surv. Ind.*, iii., 101; Brandis, *Ind. Trees*, 1906, 590; EUPHORBIACEÆ. *The kamela, kamala, kambilá, rúin, rori, sinduri, shendri, púnag, túng, gangai, rolli, puroa, kapli, kúmkuma, kurku, tawthidin*, etc. A small tree, usually with a buttressed trunk, occurring along the foot of the Himalaya from Kashmir eastwards (rising to 4,500 feet in altitude); also in Bengal, Central, Western and Southern India; Burma; the Andaman Islands and Ceylon.

D.E.P., v., 114–24.
Kamela.

Dye.

Collection.

Adulteration.

Dye.—The most important product of this tree is the *kamela* powder—a Dye formed of the red glands found on the surface of the capsule. It is used chiefly for imparting to silk a bright orange or flame colour. A full account of the history of this dye is given in the *Dictionary*. In collecting the powder, the ripe fruits are placed in a cloth or sack, and beaten until the glandular pubescence is removed. In some districts the fruits are simply rubbed between the palms of the hands, or are kneaded with the feet on the ground. The powder thus obtained is then sifted to free it from the fruits and broken pieces, and in this condition it is ready for market. Through careless collection or fraudulent admixture, the commercial article, however, is often met with in a very impure state, and this may partly account for its neglect by the Native dyers and the decrease in its consumption.

The following abstract of the available information regarding the chief localities and collecting areas may be given here:—

Bengal.

Season.

Supply.

Bengal.—The tree is fairly abundant in the forests of Puri and Singhbhum, but is scarce in other localities. In the Puri Division it is said to occur in abundance in the southern tracts. It grows wild in the forests, but attains greatest perfection in open situations. Flowers and fruits heavily on lands leased to the Khonds, who clear away all other tree growth, and carefully prune the trees every year. In the thick forests it bears few flowers and fruits. The flowering season is in December, and the fruits mature in January to February. The fruit of the Bengal plant is larger than that of the United Provinces, and doubtless yields a more abundant and better colouring matter. The dye was formerly procurable in large quantities from Raman Lall Das of Elam bazár, Birbhum, at Rs. 13 to 14 per maund.

U. Prov.

Abundance.

United Provinces.—Occurs in great quantity throughout the Kumaon, Garhwal, and Ganges Sub-Himalayan Forest Divisions. It grows wild, for the most part associated with *sál* (***Shorea robusta***). Is common in the Dun; in a few places might be said to form almost the principal tree met with. In spite of its prevalence, there is now, however, no trade in the dye, which could be landed at a railway station for Rs. 10 to Rs. 12 per 100 lb.

Panjáb

Prices.

Panjáb.—Very abundant in the Nurpur forests, Kangra. About 30 maunds are annually exported from Nurpur, where it is sold at the rate of 4 seers per rupee. The cost of 100 lb. would thus be Rs. 12-8, or, delivered at the nearest station, Patankot, would come to Rs. 16. At Amritsar it is said to fetch Rs. 20 a maund. *Kamela* is imported into Rawalpindi from the Hoshiarpur district at the latter price. The tree grows in abundance in the Simla forests, but the dye is not gathered.

Bombay.

Bombay.—The Belgaum district is the principal collecting ground for Western India. About 4,000 lb. are sold locally every year at 4 to 6 annas per lb. The price of 100 lb. delivered at Belgaum railway station is Rs. 12-8.

Madras.

Production.

Madras.—Widely distributed in the Gamsur taluk of the Ganjam district, the annual output varying from 30,000 to 35,000 lb. The cost price at Madras, including transport and delivery, is Rs. 20 to Rs. 40 per 100 lb. In Madras City there is no local demand for *kamela*, and the dye from Ganjam is all shipped to England and the Continent.

Burma.

Burma.—More common in Upper than in Lower Burma. The dye collected is estimated to cost at least double what it does in North India. There do not appear to be any regular market rates, but the prepared powder can be obtained in the jungles at Rs. 5 per viss.

Indian Methods.

Mulberry Silk.

Tasar Silk.

Indian Methods of Dyeing.—Hooper gives the following account of the method of dyeing pursued in Belgaum:—"Two lb. of silk and 1 lb. of carbonate of soda are placed in a vessel of water and boiled for a short time. As soon as the silk softens, it is removed. In the same water are then placed 20 tolas of *kamela* powder, 2½ tolas of *jinjili* (Sesamum) oil, ½ lb. of alum, 1 lb. of carbonate of soda (in addition to the 1 lb. previously used). This mixture is boiled for a quarter of an hour, and then the silk is replaced in the vessel and taken out after another quarter of an hour's boiling. The colour is deep yellow." In the Central Provinces, in dyeing *tasar* silk, the powder is first mixed with the ash of the myrobalan (***Terminalia Arjuna***) and then put in water and allowed to stand till the sediment subsides. The water is then decanted into another vessel in which is placed finely powdered *lodh* (***Symplocos racemosa***) bark. The *tasar* silk is next soaked for six hours in the preparation; then taken out and dried, put back in the fluid, dried and again submerged till the fabric obtains the desired shade.

Medicine. Oil. Timber.

Medicine.—*Kamela* is used as an anthelmintic for the expulsion of tapeworm, but its utilisation is said to be almost obsolete, and in 1898 it was omitted from the British Pharmacopœia. The seeds yield 5·83 per cent. of a bland oil. According to Gamble, the wood is of little use as timber, but is valued as a FUEL. The bark has been reported to be used for TANNING leather, but Prof. Hummel of Leeds found only 6·5 per cent. of tannin in a sample submitted to him for examination. [*Cf. The Bower Manuscript* (Hoernle, transl.), 1893-7, 103, 186; *Pharmacog. Ind.*, iii., 296–300; Lawrence, *Valley of Kashmir*, 1895, 68; *Monographs, Dyes and Dyeing*:—Fawcett, *Bomb.*, 1896, 31; Halder, *Madras*, 1896, 8; Russell, *C. Prov.*, 1896, 19-20; Hadi, *U. Prov.*, 1896, 80; Sule, *Berar*, 1896, 6; Hummel and Perkin, *Tinctorial Prop. of Ind. Dye-stuffs*; Perkin, *Class. of Ind. Dye-stuffs*, in *Imp. Inst. Journ.*, March 1897; Perkin, *Colouring Matter of Cotton Flowers and Note on Rottlerin*, contrib. from Res. Lab. Dyeing Dept. Yorkshire, Col. 1897; *Adulterat. of Kamala, Journ. Soc. Chem. Indust.*, June 30, 1900, xix., No. 6; Dutt, *Mat. Med. Hind.*, 1900, 232-3; *Imp. Inst. Journ.*, 1900, vi., 209; *Rept. Cent. Indig. Drugs Comm.*, 1901, i., 120; *Agri. Ledg.*, 1902, No. 1, 52; 1905, No. 4; *Imp. Inst. Tech. Repts.*, 1903, 216-7, app. 213-5; Joret, *Les Pl. dans L'Antiq., etc.*, 1904, ii., 348.]

D.E.P., v., 124-40. Malt Liquors.

MALT LIQUORS and Indian Brewing.—The manufacture of BEER embraces two distinct operations—*MALTING* and *BREWING*. In the time of Herodotus (450 B.C., bk. ii., ch. 77) there was no separate name for beer; he accordingly speaks of the Egyptians as making wine from barley. Dioscorides, Galen and others condemn beer as prejudicial to the head and nerves.

Beer. Fermented Grain. Discovery of Hops. Association with Mongolians. **Ale.** Fermented Sweet Liquors.

History.—The Hindus, as well as most of the aboriginal tribes of India, have been acquainted with both distilled and fermented beverages from very ancient times. But it is curious that while full particulars exist regarding the more advanced art, viz. that of distillation, the rationale of malting as a distinct stage in the production of fermented beverages does not appear to have been understood. Indeed it has been contended that, even in England, malting as a separate operation was not known until the time of Henry VIII., when the use of hops was also discovered. A fermented but non-distilled liquor may be said to have been prepared all over India, the materials varying according to the region or people, but in no instance has malting as a distinct and necessary stage been recorded. And what is perhaps even more striking, a fermented beverage made from grain would seem, so far as India is concerned, to have been more closely associated with the Mongolian than with the Aryan races. With the latter branch of the human family sweet liquids, such as honey and water, cane-juice and water, or the sap of various palms, were fermented into beverages that would more closely correspond with the ancient mead of England or the ales subsequently in favour, than with the beer of modern trade. It would be thus easy to understand why the art of malting was not known, since unnecessary, indeed almost impossible, under these circumstances. The most general Indian name for fermented sweet liquors is possibly *tárí*, though *sendhi* is sometimes used almost synonymously, while *pachwai* (or *handia* and *marua*) denote malted and fermented beverages made from grain, mostly rice, though barley and millet are also utilised (see p. 840).

Beer. *Buzah.*

The English word "beer" came through the Anglo-Saxon *beor* and the German *bier*—words which indicate the grain used in the fabrication of the beverage. The Asiatic word which in meaning most closely approaches "beer" seems to be *buzah* or *buza*, a Turkish word adopted into Persian and ultimately into many languages in India and Africa. It is, however, the name more used by the well-informed, *pachwai* being the every-day word for beer or malted liquor made from grain. Shaw (*Travels, etc.*, 1757, 407) speaks of the Egyptians making a fermented and intoxicating liquor, known as *bouzah*, from barley. Moorcroft (*Travels*, 1819–25, i., 162), while describing Ladakh, says that the inhabitants make "a sort of beer called *buza* from barley, the grain of which is parched and ground, and the flour mixed with rice which has been softened by steeping in water. The powder of the root of some bitter and aromatic plant that grows higher up in the mountains is added to the mixture, and the whole is put into a press to squeeze out the water, and dried. When required for use a piece of the dry cake is thrown into a vessel of water, and in

Tibetan *Chang.*

Kim.

the course of three or four days fermentation takes place and the liquor is ready for drinking." In another passage, Moorcroft remarks, "The Tibetans never drink plain water if they can avoid it. The wealthier drink grape-juice and water, or sherbets; the poorer, a beverage called *buza* by the Kashmiris, and *chang* by the Tibetans, which is made from barley. The grain is boiled until it is soft, and then dried; to about 10 lb. of this softened grain, three ounces of the dough used for wheaten cakes, but dried and pounded, are added, and the mixture is put into a bag and kept in a warm place until it ferments, which it does usually in two or three days. Equal measures of the prepared barley and cold water are put together in an earthen vessel. After standing for two days the fluid is strained off; a similar quantity of water is again added, and treated in the same manner, and the beverage is the liquor called *chang*." "The grains remaining after infusion are dried, and ground into flour." The above passages bring to mind the account of *buzeh* as given by the Emperor Baber in his *Memoirs* (1525, 283, 294), speaking of Sewad and Bajour (practically the same country), and thus three hundred years before Moorcroft's time. The passage has already been quoted under **Eleusine** (p. 520), and there would seem little doubt that the substance called *kim*, which was "round like a loaf," was the softened grain (whether barley or *marua*), with its ferment and bitter flavouring ingredient, taken from the cloth in which squeezed to deprive it of its moisture, and thus compressed into what might easily be described as a sort of loaf. Aitchison (*Fl. Lahul, Journ. Linn. Soc.*, 1869, x., 76) says that "from barley, as well as from rice ('*drai,*' '*dai*') a kind of beer is made, called *chung*." In making *chang*, a ferment is used, called *pab*, imported from Ladakh in the form of dry yeast. "The Lahulees admit their ignorance as to its nature and their non-ability to make *chung* without it." In the Hemp Drugs Commission's Report (1894. i., 157) mention is made of a liquid preparation used in Sholapur, Bombay, under the name *boja*, which consists of a gruel made of *juár* (**Sorghum**, p. 1040) flavoured with hemp and a little *Nux vomica*.

Buza.

The practice of making *buza* or beer from barley is thus quite as ancient in India, very possibly, as in Europe. In passing it may be added that the great conquering Emperor Baber tells us he did not like "*buzeh*" because of its bitter flavour—the Indian objection to-day to European beer. (See **Cannabis sativa**, p. 257.)

Naga *Dzu*

Under **Coix** (p. 396) particulars will be found of the Naga hills beer, known as *dzu*. This is, undoubtedly, a fermented beverage made either from coix or rice or both mixed, the one fermented and the other not. Grain is placed in a large wooden trough and hot water poured over it. It is then left to malt, and, when this stage is complete, a further quantity of boiling water is added. In three days' time the liquor is in prime condition, and by the fourth or fifth day it becomes intoxicating. It has already been pointed out that the dispersion of coix grain over India and Burma accompanied the Mongolian invaders, and further that the name *kasi* or *kasai* or some obvious derivative from that word was conveyed to remote countries and into diverse tongues.

Ferments.

Ferments.—Bergtheil (*The Study of Fermentation as Applied to Agriculture*, in *Agri. Journ. Ind.*, i., pt. i., 68–75; pt. iii., 230–6) reviews some of the more interesting modern opinions regarding FERMENTATION. Among all races and in every age, he says, we find a knowledge of some means for the production of alcohol, all fundamentally depending on the fermentation of sugar. In many instances the initial action is the conversion of starch into sugar by an enzyme action,—the "malting" of barley. The grains are placed under conditions favourable for germination, and when the production of a soluble, easily assimilable food for the infant plant has been accomplished, the grains are killed. The further stage, namely, the fermentation of the sugary fluid into alcohol, is ordinarily accomplished by a fungus, known as yeast. "In Western countries," writes Bergtheil, "yeasts and their actions have been carefully studied, and pure cultures of special yeasts, which have been found most suitable for the production of the particular type of fermentation desired, are deliberately introduced and their growth most carefully regulated and guarded; in other cases, such as those we are familiar with in India, wild yeasts are allowed to gain access from the air and grow in the liquid to be fermented, but under all circumstances a yeast or closely allied organism is necessary to the process."

Bakhar.

Mathosan

Paps.

From the facts already briefly reviewed, it may be inferred that this art of fermentation is fairly understood in India. In most *Excise Reports of Bengal* mention is made of a ferment known as *bakhar*—a compound prepared from the roots and leaves of several plants (names unknown, but innocuous) (see **Spirits,** p. 1047). In most cases the yeast used is conveyed from one brew to another. The bakers of the lower provinces of India, for example, regularly purchase their supply from the palm-wine (*tari*) manufacturers. In Upper India numerous ferments are known. For example, while travelling in Kullu and Ladakh my attention was drawn to the ferments employed by the people in these countries. I found that in Kullu the brewers of *sur* (grain beer) sent, just as Moorcroft tells us, up country for the root of a herb which they employed in brewing. In Kullu this is known as *mathosan*, and seems to be a species of ***Ligusticum.*** The root is reduced to powder and mixed with damp barley flour. Fermentation is soon set up, and the mixture is then baked into cakes and dried. These are sold under the name *dheli*, and are said to preserve the fermentative germ for an almost indefinite period, and may be used either by the baker or the brewer as desired. In Ladakh I was unable to discover the plant employed, but the cakes are there known by the name *paps* (see above, *pab*). [*Cf. Ann. Rept. Ind. Mus.*, 1894–5, 35.]

In Manipur I discovered that the powdered stems of a leguminous plant (possibly a species of ***Millettia***) were employed as the fermenting material, and Mr. C. B. Clarke says that in the Khasia hills the people procure fermentation from the flowering spikes of a ***Rhyncospora.*** [*Cf. D.E.P.*, v., 131–6; Lawrence, *Valley of Kashmir*, 1895, 82.]

D.E.P., iv., 302–7; v., 130. Hops.

Indian Grown.

Hops and Substitutes.—On more than one occasion the effort has been made to cultivate hops (***Humulus Lupulus***) in India, but with indifferent results. The amount required by the brewers in India is annually imported. Hooper (*Rept. Labor. Ind. Mus.* (Indust. Sec.), 1906–7, 12) gives the results of his chemical examination of a sample of hops grown in Kashmir. By way of comparison, he exhibits the amounts of resin (ascertained by Coez's benzol method) in certain trade samples :—Californian, 21·0 ; East Kent, 18·7 ; Kent, 17·8 ; Bohemian, 15·6 ; North French, 14·8 ; Kashmir, 13·2 ; and other Indian samples, 12·9. Thus Kashmir is not far behind French hops.

Soma.

By the Indian makers of liquors, various substances are used as substitutes for hops, the most general being the distiller's bark (see **Acacia leucophlœa,** p. 15), but in this connection it may be of interest to invite attention to the suggestion that the *soma* of the ancient classical writers may have been the astringent stems of ***Ephedra*** (*D.E.P.*, iii., 247–51) employed in place of hops, and not as itself the source of the liquor of which so much has been written.

Barley.

Special Qualities.

Barley.—All forms of barley (p. 643) are not equally suitable for brewing any more than all forms of coix are suited (see p. 396). The best Indian barley comes from Northern India (United Provinces and South Panjáb). Plumpness of grain and uniformity in weight are desirable. The finest Indian samples weigh 56 lb. per bushel. The grain must also be bright in colour and not "steely"—the condition of most of the samples from the plains. But above all, it must be living and capable of active germination during malting, and must not have germinated before reaching the brewery. Damaged grain will rot during malting, and thus lower very greatly the value of the material. [*Cf. D.E.P.*, v., 128.]

The grain must be thoroughly screened and winnowed before it is placed in the steeping-vats. It is now conveyed to the malting-floor, where it softens and germinates. Simultaneous and uniform malting is essential. When malting is completed, the grain is again screened to remove the rootlets, then crushed, infused with water and hops added. The infusion is next fermented, and shortly after the liquor is ready for bottling and casking.

Indian Beer.

Indian Ale.

Indian Indigenous Brewing.—No one has hitherto attempted to produce a definite statement of the art of brewing and of the beverages produced for the whole of India. In the *Excise Reports* issued annually by the various Provincial Governments, brief paragraphs now and again deal with what appear to be beverages akin to beer and ale. As already explained, *pachwai* is made from fermented grain, mostly rice; it is thus a form of beer, but when distilled it becomes a kind of spirit or whisky, and in that case is called *phatika* or *madira.* On the other hand, toddy or *tari* (palm juice) fermented, but not distilled, corresponds very closely with the theoretic definition of ale, and when distilled becomes the spirit generally called *arak.* But palm juice is often drunk without being fermented, and is then spoken of as "sweet tari." For this purpose the law requires that a private person tapping his own trees must wash the interior of the collecting vessels with lime-water so as to prevent fermentation taking place. Similarly a sweet drink or fermented ale is often prepared from *mahua* flowers.

Pachwai.

Tari.

Yeast.

In the *Excise Reports* for both Bengal and Assam, *pachwai* and *tari* are mentioned. (See **Oryza** (Revenue), p. 840.) The licenses granted for home-brewing of *pachwai* are explained: these are issued (mostly to hill tribes) without limit as to quantity, but at a fixed annual fee. The beverage cannot, however, be sold. In the Central Provinces the revenue from *tari* consists of license fees paid for the right to manufacture and to vend. But *pachwai* and *sagda* are in these provinces spoken of as "Native Beer." [*Cf.* Hooper, *Rept Labor. Ind. Mus.* (Indust. Sec.), 1903–4, 35.] In the reports of the United Provinces reference is given to *tari* (the juice of ***Borassus***), to *sendhi* (the juice of ***Phœnix***), to *boza*, a fermented liquor made from rice, and to *darbahra*, a fermented beverage from various herbs (not known). Of Madras, mention is made of both sweet and fermented "toddy" collected from the cocoanut, sago, palmyra and date palms, also from a palm not previously recorded as affording the juice, namely the *dadasal* or *dadsel* (***Arenga Wightii***). Of Bombay toddy, it is said the revenue in 1903–4 came to Rs. 15,52,000. This was raised both by a tree tax and a vendor's license. The chief trees tapped are the date palm, the *brab* (***Palmyra***) and the cocoanut. The total number of trees tapped in 1903–4 was 231,245. Unlike Madras, tree-tapping for sweet toddy is not permitted, as fermentation is said to be set up immediately the juice is drawn from the stem. In a special experiment separately reported, thirty-two *brab* trees yielded in Salsette during the month—February 16 to March 15, 1904—a total of 176 gallons of toddy. The Burmese reports speak of "fermented" liquors under two headings—(*a*) other than *tari*, and (*b*) *tari*. The consumption of fresh *tari* is allowed without being subject to a tax, and the owners of trees may sell the juice obtained from their trees to professional *tari* makers without paying any fees. Of the non-*tari* beverages, mention is made of *kaung*, *seinye*, *hlawza* and *seye.* These are said to be manufactured from rice, fermentation being procured by yeast. It would seem that a mistake may have been made regarding both the grain and the ferment. Coix is certainly largely employed by the hill tribes, but the ferment need not be yeast as understood in Europe. (See **Bassia**, pp. 118–9; **Borassus**, pp. 170–1; **Caryota**, p. 286; **Cocos**, pp. 361–2; **Phœnix**, p. 886; **Setaria**, p. 988; **Spirits**, p. 1047.)

Anglo-Indians.

European Beer.—Turning now to Indian beer brewed after the European method. In the writings of the early European visitors to that country, frequent mention is made of "beer" or of "country ale," but whether these were malted beers or merely the various sweet-liquor beverages already indicated, under the name toddy or *tari*, it would be difficult to say. The English word "toddy" comes, of course, from the Indian *tari*, and was originally, and in India is to-day, the fermented sap of the *tar* palm. Friar Jordanus (1328 A.D.) speaks of the tree that gives all the year round a white liquor, pleasant to drink, which tree is called *tari*. Sidi Ali Reis refers to the wine obtained in Gujarat from the *tari* tree. On the other hand, Mandelslo (*Travels*, in Olearius, *Hist. Muscovy, etc.* (Davies, transl.), 14; also *Hobson-Jobson* (ed. Crooke), 738 mentions that the captain of the ship in which he journeyed to Surat had excellent good sack, English beer, French wines, *arak*, and that they prepared from the latter good punch (*palepunzen*). Ovington (*Voy. to Suratt*, 1689, 238, 395) says "no Malt drink is made in India"; and again, "Europe Wines and English Beer," though expensive, were "yet purchased and drank with pleasure." Tavernier (*Travels*, 1676 (ed. Ball), ii., 368) tells us that the President gave him a large cask of "English beer" to take with him to Batavia, where none could be had. Birdwood and Foster (*E.I.C. First Letter Book* (Introduction), xxi.) describe the "Cock Ale" in use in the 17th century. It consisted of a bruised cock (the older the better) with 3 lb. of raisins, mace, cloves, etc., two quarts of sack and ten gallons of ale, the whole being left to ripen as with other ales. Punch was another special Indian preparation, and "milk punch" has survived to the present day—the last of a long list of Anglo-Indian preparations—a sort of home-brewed or concocted liquor. [For further particulars see the articles on **Opium**, pp. 845–61, **Tobacco**, p. 796, and **Spirits**, pp. 1043–8.]

Breweries.

First Indian Brewery.

Indian Breweries.—Within recent years "Country Beer" has come to mean beer brewed in India after the European system. The first European brewery in India was started in 1825 by a Mr. Henry Bohle at Meerut and Mussourie, but in time the business was taken over by Mr. John Mackinnon. It was not, however, until 1870 that the enterprise became successful. In the meantime, between 1850 and 1860, several breweries were started on hill stations. The official statistics of the larger establishments show that in 1880 there were seventeen breweries in India producing 1,974,578 gallons of beer made after the European system; in 1890, 22 breweries producing 5,192,572 gallons; in 1900, 26 breweries producing 4,947,841 gallons; and in 1904 there were 27 breweries producing 6,219,761 gallons, of which the Commissariat Department purchased 2,839,177 gallons, or a little under half the production. These figures abundantly demonstrate the rapidity with which brewing had developed, and its present position. The breweries and shares of production in 1904–5 are as follows:—Panjáb, 8 breweries and 2,233,955 gallons; United Provinces, 6, and 1,451,796 gallons; Madras, 4, and 416,852 gallons; Mysore, 3, and 700,281 gallons; Bombay, 1, and 558,767 gallons; Baluchistan (Quetta), 1, and 338,580 gallons; Burma (Mandalay), 1, and 306,396 gallons; Central Provinces (Jabbalpur), 1, and 130,194 gallons; Bengal (Sonada), 1, and 82,940 gallons.

Production.

Consumption.

Consumption of country-brewed (English) beer and ale by the Natives of India is not important, though in some provinces it is more extensive than in others. In Madras these beverages are fairly popular, especially in the hill districts, and in the Panjáb mention is made in the *Excise Reports* of the demand being on the increase.

Trade.

Early Imports.

External Trade Returns.—The rise and fall in the popularity of imported ale, beer and porter may be said to mark the steady progress of European opinion against the use of strong drinks, and of large quantities of liquors of any kind in tropical countries. The first importation of beer from London recorded in modern commerce may be said to have been consigned from Hodgson's brewery in 1816. This was ultimately known as "Hodgson's Pale Ale." By 1825 the beers made by Bass, Allsopp, Ind and Smith, etc., had found their way to India. It is within the recollection of those still living that a guest was supplied with a basket of four or six bottles of beer and was supposed somehow

Special Demand.
Competition.

to get through that supply during the repast. For many years this practice has died out, and the demand been steadily made for a higher grade, lighter beer. This was first met by the Indian brewers. But in time there appeared on the Indian markets not only new firms with light ales and beers, but all the older ones had to respond to the popular desire, and in consequence of this keen competition the Indian breweries lost temporarily some portion of the position they had attained.

Imports.
Total Traffic
Contributing Countries.
Receiving Ports.

Imports.—To contrast with the Indian production, already given, the following figures of the import trade may now be recorded. In 1900–1 India received of ale, beer and porter, 3,226,534 gallons, valued at Rs. 46,82,648; in 1902–3, 3,820,938 gallons, valued at Rs. 51,66,378; and in 1904–5, 4,607,530 gallons, valued at Rs. 60,41,973 (£402,798), or say, on an average, two-thirds the quantity brewed in India. In subsequent years the imports were:—1905–6, 5,002,448 gallons, valued at Rs. 62,95,616; and in 1906–7, 4,916,294 gallons, valued at Rs. 60,27,011. Of these foreign imports by far the major portion comes from the United Kingdom. Out of the totals mentioned, for example, the United Kingdom supplied in 1900–1, 3,014,064 gallons; in 1902–3, 3,581,544 gallons; and in 1906–7, 4,506,145 gallons, the only other important country being Germany, with an average of over 200,000 gallons for each of the past five years. The receiving ports are Bombay—the chief emporium for the large military towns of Northern India—followed by Burma, Bengal, Sind and Madras, in the order of importance named. It seems, however, that some of the beers imported from England may be of German origin, though it is perfectly true that Pilsener and Lager are now merely trade names for certain qualities of light beers, and do not necessarily denote German manufacture.

[*Cf.* Battershall, *Food Adult. and Its Detect.*, 1887, 132–56; Southby, *Practical Brewing*, 1895; Allen, *Comm. Organ. Anal.*, 1898, 80–5; O'Gorman, *Malt Liquors of Ind.*, in *Ind. Med. Gaz.*, 1899, 200–3; Blount and Bloxam, *Chem. for Engin. and Manuf.*, 1900, 189–208; Blyth, *Foods, Their Compos. and Anal.*, 1903, 410–1, 408–40; *Journ. Soc. Chem. Indust.* (numerous passages).]

D.E.P., v., 144–6.

MANGANESE; Ball, *Man. Econ. Geol. Ind.*, iii., 326–32; Bose, *Manganese-iron and Ores of Jabbalpur*, in *Rec. Geol. Surv. Ind.*, 1888, xxi., pt. 3, 71–89; 1889, xxii., pt. 4, 216–26; 1904, xxxi., pt. 1, 47–8; pt. 4, 235–6; Holland, *Rev. Min. Prod.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., pt. 1, 13, 55–63; 1906, xxxiii., pt. 2, 94–100; Fermor, *Trans. Min. Geol. Inst. Ind.*, 1906, i., 69–131. In India the commonest ores are *psilomelane*, a complex manganate; *braunite*, a sesquioxide and silicate combined; and *pyrolusite*, or the black peroxide. The peroxide has the following names, *kolsa-ka-pathar*, *ingani*, *nijni*, *iddali kalu*, etc.

Output.
Classification

Production.—In 1906 India took the first place among the manganese-producing countries of the world. In 1903 the output was 171,806 tons; in 1904, 150,297 tons; and in 1905, 253,896 tons. The most important deposits occur in the Central Provinces, Madras, Central India and Mysore. In 1905 the production of the Central Provinces was 159,950 tons; in Madras, 63,695; and in Central India, 30,251. Investigations into the manganese-ore deposits of India were started in 1903–4 by the Geological Survey, and a summary of the results is given by Fermor. It has been shown that the deposits can be classified into (*a*) *braunite, psilomelane* and *pyrolusite*, associated with and derived from manganese-bearing silicates in the Archæan schists and gneisses. Examples occur in Nárukot in Bombay; Jhábua in Central India; Bálaghát, Bhandára, Chhindwára and Nagpur in the Central Provinces; Ganjam and Vizagapatam in Madras. (*b*) *Psilomelane and pyrolusite,* in part superficially formed on outcrops of rocks of Dharwar age, with which the ores are also embedded. These occur in Singhbhum in Bengal; Dharwar and Panch Mahals in Bombay; Jabbalpur in the Central Provinces; Sandur hills in Madras. (*c*) *Psilomelane and pyrolusite,* associated with or contained in laterite. These occur in Belgaum and Satara in Bombay; Jabbalpur in the Central Provinces.

Chief Centres.—Panch Mahals in Bombay; Jhábua in Central India; Bálaghát, Bhandára, Chhindwára and Nagpur in the Central Provinces; Vizagapatam and the Sandur hills in Madras; and Shimoga district, Mysore, are the localities in which economically important deposits are located and worked.

Uses.

Uses.—The uses to which the ores of manganese are put are somewhat varied. The peroxide is extensively employed in glass-making, to destroy the green colour. The same oxide is used in porcelain painting and glazing for the fine brown colour it yields, while violet colours are got from the carbonate (*Ind. Art at Delhi,* 1903, 22). The ores are now mainly employed in the manufacture of ferro-manganese for use in the manufacture of mild steel. For use in steel-making, manganese ores should not contain more than 0·25 per cent. phosphorus, nor more than 10 per cent. silica. Under conditions laid down by the Carnegie Steel Company, ores containing less than 40 per cent. manganese and more than 0·27 per cent. phosphorus or 12 per cent. silica may be rejected at the option of the buyer. Holland deplores the exports, since "the whole industry is at present equivalent to a heavy loss to the country." The ore exported is worth perhaps Rs. 30 a ton, whereas India gets merely the margin left after paying the heavy freight charges, and possibly Rs. 15 a ton can be regarded as the profit divided between the railways, the miners and the owners. He then concludes: "If a flourishing steel-manufacturing industry existed in the country, much of the manganese would be retained in India, and the lower-grade ores would be economically developed. As it is, our manganese-ore is being exported to the three great steel-producing countries—England, United States and Germany."

Ferro-manganese.

India's Share in Profits

Trade.

Trade.—As regards foreign trade, the EXPORTS have in recent years shown a considerable increase, especially in 1905-6. In 1900-1, they amounted to 2,613,394 cwt., valued at Rs. 12,51,639; in 1904-5, to 3,618,909 cwt., valued at Rs. 24,07,681; and in 1906-7, 9,859,855 cwt., valued at Rs. 70,88,280. The largest quantity goes to the United Kingdom, viz. in 1906-7, 4,392,130 cwt. Then follow the United States, 2,786,400 cwt.; Belgium, 1,971,614 cwt.; France, 669,710 cwt.; Holland, 40,000 cwt. In the same year the share of Bombay in the exports was 7,010,863 cwt.; Madras, 2,130,701 cwt.; Bengal, 718,291 cwt. Tables showing the variation in the price of manganese ore at the United Kingdom ports since 1890 are given by Holland. In 1903 the price for ore carrying over 50 per cent. of the metal, delivered at United Kingdom ports or at New York, ranged between 9 and 10 pence per unit, or in other words, an ore containing 52 per cent. manganese would be valued at 39 shillings a ton. These prices have considerably risen since, and during 1906 reached 16 pence per unit, the higher rates having greatly stimulated production in India.

Exports.

[*Cf. Rev. Min. Prod. Ind.*, 1893, 12; 1894, 22; 1895, 46–7; 1896, 47–9; 1897, 47–8; Jeremiah Head in *Journ. Iron and Steel Inst.*, 1896, No. ii.; *The Min. Indust.*, 1897, vi., 470–1; 1899, viii., 424; 1901, x., 445; *Rept. Chief Inspect. of Mines, Ind.*; Levache, *Manuf. of Varnishes, etc.* (McIntosh, transl.), 1899, 309–13; Thorpe, *Dict. Appl. Chem.*, 1899, ii., 498–500, etc.]

D.E.P., v., 146–57. Mango.

MANGIFERA INDICA, *Linn.*; *Fl. Br. Ind.*, ii., 13; Talbot, *List Trees, etc.*, 1902, 113; Gamble, *Man. Ind. Timbs.*, 1902, 211–3; Duthie, *Fl. Upper Gang. Plain*, 1903, 189; Cooke, *Fl. Pres. Bomb.*, 1903, i., 273–4; Brandis, *Ind. Trees*, 1906, 206; ANACARDIACEÆ. The Mango Tree, *am*, *uli*, *jegachu*, *ghariám*, *tsaratpang*, *marka*, *mawashi*, *maá*, *mangas*, *mámadi*, *marína*, *thayet*, etc. A large evergreen tree of the Tropical Himalaya, at 1,000 to 3,000 feet, from Kumaon to Bhutan, the Khasia hills, Burma, Oudh, lower hills of Bihar, and in the Western Peninsula from Khandesh southwards. According to De Candolle it is a native of the south of Asia or of the Malay Archipelago.

The mango has been known and cultivated all over India from a very remote epoch. It is closely connected with Sanskrit mythology, and finds a place in old Hindu tales and folklore. Mention is made of it by Friar Jordanus, who wrote about 1328, and by most of the early Indian travellers. Varthéma in 1510 describes it under the name of *amba*, and Baber, in 1526, speaks of the excellence of the fruit. Again Garcia de Orta, in 1563, writes that those of Hormuz are so good, when in season, that no other fruit can be sold; he then describes the various kinds known.

Cultivation.

Soils.

Cultivation.—Mangoes can be grown from seed, but it is the general belief that seedlings rarely produce fruit equal to the parents, and the usual method of propagation is by inarching. According to Maries, the best place to plant the mango is on a raised, well-drained piece of land with a good depth of soil. The nature of the soil does not appear to interfere much with the growth of the tree. In Bengal it succeeds equally well on a rich, deep river deposit, on clayey or on sandy soil; and in Gwalior, Maries wrote that fine trees were grown on *kankar*, *i.e.* soil with a large proportion of lime nodules.

Inarching.

Inarching.—The "stones" are usually sown at the time the fruit is in season, and the plants raised from them are potted to be grafted by inarching with desirable plants. This is accomplished during the setting-in of the rains in the second year of the growth of the seedling. At the close of the rains the union is usually complete. The essential points in this method of grafting are to bring the cambium of the stock and scion together before the graft is completely severed, the parts being bound together so as to exclude air and water and keep the plants healthy during a short growing season. Care should be taken that the scion be of the same thickness as the stock.

Planting Out.

Manuring.

Distance Apart.

Planting Out.—The best season for planting out the young grafts is the monsoon. The following is a brief account of the method recommended by Woodrow (*The Mango, Cult. and Varieties*, 1904, 11). Having selected the plot of ground, holes should be dug about 3 feet in dimension. The centre of the holes should be about 20 feet distant from each other. About 20 lb. of fresh bone manure should be placed in the bottom of each. The soil on the margin should then be drawn in to a depth of about 9 inches, and the surface soil, mixed with manure, placed on the top. The holes are now ready to receive the grafts. The soil that is left over is put round the margin as a ridge, or *thala*, to form a dam which causes the water given to the young graft to sink

Fruiting Age. Seasons. Flowering and Fruiting.

near the root. Firm stakes and shade are desirable during the following six months, and the intervening land may be cultivated with moderately irrigated and richly manured crops till the trees have attained flowering size. In five years the plants should be fit to bear a considerable quantity of fruit. When fruiting age is attained, there is no necessity for irrigation from the time the rain ceases in September till the young fruits appear; thereafter, irrigation about once in fifteen days is desirable while the fruits are increasing in size, but may be discontinued when ripening approaches. The surface soil should be kept in a loose, friable state to cause the water to pass downwards. The general flowering season is from January to March, and ripening from May to August, but varieties flower and ripen at all seasons.

Fruit. Best Localities. Mango Weevil.

Fruit.—The cultivated kinds of mango are very numerous, but the reader need only be referred to the list given by Maries in the *Dictionary*, and to the accounts by Firminger (*Man. Gard. Ind.* (ed. Cameron), 1904, 256–61) and by Woodrow (*l.c.* 25–32). An interesting paper by Maries in the *Journal of the Royal Horticultural Society* may also be consulted. The two principal localities in India where the finest fruits are said to be produced are Mazagon at Bombay and Malda in Bengal. On the other hand, the fruit ripens so badly and is so much diseased in Assam that it is hardly ever seen to be cultivated, except as a shade-tree. Maxwell-Lefroy gives an account of the Mango Weevil (*Agri. Journ. Ind.*, i., pt. ii., 164–5) which is so very destructive to the fruit.

Preserves and Pickles. Medicine.

Besides being eaten as a ripe fruit, numerous preparations are made of it. When green it is cut into slices, and, after extraction of the stone, is put into curries, or made into pickles with other ingredients or into preserves and jellies. When young and green it is boiled, strained, mixed with milk and sugar, and thus prepared as the custard known as *mango-phul*, or dried and made into the Native *ambchúr*. When very young it may be cut into small pieces and eaten in salad. So again, the ripe fruit is used in curries and salads, and the expressed juice when spread on plates and allowed to dry is formed into the thin cakes known as *ambsath*. Attempts to bring the fresh mango on the London market, at a paying price, have hitherto been unsuccessful, but if it could be conveyed cheaply to England, a trade that would rival the fruit of the West Indies might be immediately anticipated. In times of famine the kernels are eaten. Preserves, chutnies and pickles made from mango fruit are largely exported to England and elsewhere. In MEDICINE, the ripe fruit is considered invigorating, fattening, laxative and diuretic, but the fibrous rind, as well as the unripe fruit, are astringent and acid.

Timber. Gum. Dye.

Timber.—According to Gamble, the WOOD is used for planking, door and window-frames, in Calcutta for packing-cases, and in Bihar for opium and indigo boxes. Canoes and *masúla* boats are also made of it, and in Dehra Dun and some other tea districts it is in large demand for tea-boxes. Hooper (*Rept. Labor. Ind. Mus* (Indust. Sec.), 1906–7, 8) says that samples of the resinous substance procured from the tree were found to contain 79 per cent. of resin and 15 per cent. gum. Some samples also contained an insoluble gum like tragacanth. The bark and leaves yield a yellow DYE of which little use is made; one of the curiosities of the industrial uses of the tree is the *peori* (or Indian yellow) made from the urine of cattle fed on the leaves. (See **Coal Tar Dyes**, pp. 345, 707.)

THE CASSAVA PLANT

[*Cf.* Varthéma, *Travels*, 1510 (ed. Hakl. Soc.), 159; Baber, *Memoirs*, 1526 (Leyden and Erskine, transl.), 324; Garcia de Orta, 1563, *Coll.*, xxxiv.; Acosta, *Tract. de las Drogas*, 1578, 317; Linschoten, *Voy. E. Ind.*, 1598 (ed. Hakl. Soc.), ii., 23-6; Pyrard, *Voy. E. Ind., etc.*, 1601 (ed. Hakl. Soc.), ii., 367; Jacobus Bontius, *Hist. Nat. et Med. Ind. Or.*, in Piso, *Ind. Utri. Re Nat. et Med.*, 1629, 95; Terry, *Voy. E. Ind.*, 1655 (ed. 1777), 91; Boym, *Fl. Sin.*, 1656, H.; Mandelslo, *Travels*, 1662, in Olearius, *Hist. Muscovy, etc.*, 148; Fryer, *New Acc. E. Ind. and Pers.*, 1675, 182; Crawfurd, *Journ. to Ava*, 1834, ii., 218-9; *Pharmacog. Ind.*, i., 381-5; Moodeen Sheriff, *Mat. Med. Mad.*, 1891, 120-2; Nicholls, *Textbook Trop. Agri.*, 1892, 85; Woodrow, *Gard. in Ind.*, 1899, 239; Maries, *Ind. Mangos*, in *Journ. Roy. Hort. Soc.*, 1901-2, xxvi., 755-70; Joret, *Les Pl. dans L'Antiq., etc.*, 1904, ii., 286-7.]

D.E.P., v., 157. Tapioca. **MANIHOT UTILISSIMA,** *Pohl.*; *Fl. Br. Ind.*, v., 239; Gamble, *Man. Ind. Timbs.*, 589; Prain, *Beng. Plants*, 1903, ii., 940; *M. palmata, Muell.*; *Kew Mus. Guide*, 1907, 187; EUPHORBIACEÆ. Cassava, Tapioca, Manioc, Mandiocca, *mararuli*, *marachini*, *simla-alu*, *simul-alu*, *pulu pinan myouk*, etc. According to De Candolle, this is a native of America, but cultivated for so long that the wild parent is no longer recognisable. At the present day there are many widely different races. Some botanists, moreover, regard *M. palmata* as a separate species, others only as a variety of *M. utilissima*, from which it differs chiefly in the absence of the acrid taste and poisonous principle of the latter. On this account *M. palmata* is known as the sweet, while the other form is the bitter cassava (see p. 444).

Cultivation. Cassava is cultivated in most of the provinces of India, and in view of the fact that it is a drought-resisting plant, requiring only about 14 to 16 inches of rain per annum, there has been considerable discussion as to whether its cultivation should not be more widely extended, in view of its value in times of famine. **Stem Cutting** The soil should be rich and light. Propagation is carried on by cuttings from the stem, 4 to 8 inches long, which are half buried in the soil at an angle of 45° and placed in rows 4 feet apart. Planting can be done during the whole year, **Irrigation.** but the best time is at the close of the cold season. Irrigation is employed in some parts, chiefly about Pondicherry and Travancore, but hardly elsewhere. During the first two months the young plants require a moderate supply of water. After the crop is planted, no special cultivation is necessary except to **Weeding.** keep the soil free from weeds.

Seasons. The time the crop takes to mature depends on the particular race grown. Most require about twelve months, though some only six and others as many as eighteen. The yield per acre is very variously stated. In all cases it is large, running from about 2,500 lb. to as much as 30,000 lb. or more (*Agri. Ledg.*, 1904, No. 10, 144-5).

Crop. From the roots, various preparations are made. The preliminary operations are the same. **Preparation** The roots are scraped, carefully washed, and then reduced to pulp by being passed through rollers. Subsequent stages vary according to the product required, the most important of which are couac, cassava meal, Brazilian arrowroot and tapioca. Couac is a coarse meal obtained from the pulp by expressing the juice and then pounding and drying the remaining **Cassava and Tapioca.** particles. Cassava meal is simply couac of a greater degree of fineness. Brazilian arrowroot is the starch washed out of the root, and tapioca is the same slightly parched. In Cuddalore and Pondicherry the roots are sold after having been part boiled (*Agri. Ledg.*, *l.c.*, 125). The juice of the tubers of the bitter variety can be converted by boiling into a valuable product widely known as *cassareep*. It is a wonderful antiseptic, will preserve fresh meat for considerable periods, and is also the chief ingredient in many sauces.

Chemistry. It was formerly supposed that the root consisted chiefly of starch with a varying quantity of prussic acid, which latter in the case of the "sweet" cassava was confined to the bark, but in the "bitter" occurred throughout the root. **Poisonous Property.** To this prussic acid the numerous cases of cassava-poisoning which have at various times occurred were said to be due. Leather, however (*Cyanogenesis in Plants*, *Agri. Journ. Ind.*, 1906, i., pt. iii., 223-4), states that a number of varieties were examined by him at Poona in January 1904, and that none were found to contain any prussic acid as such, but that all manifested a cyanogenetic glucoside "associated with an enzyme which has the property of causing the splitting up of the glucoside, and the consequent formation of prussic acid." In exemplification of this he gives particulars regarding the glucoside *dhurrin* in the leaves of the *juár* (**Sorghum vulgare**, see p. 1040) and of the glucoside in the present plant. "I was able," he adds, "to establish three facts: *firstly, none* of the varieties contained any prussic acid as such; *secondly, all* the varieties, irrespective of the colour of the petiole or other botanical features, contained a cyanogenetic glucoside, which varied much in amount; *thirdly*, this glucoside is associated with an enzyme which has the property of causing the splitting up of the glucoside, and the consequent formation of prussic acid. As in the case of *juár* leaves, it is only necessary to crush tapioca root with water in order to bring about this change. The amount of prussic acid varied very much; from some roots 1·5 grains of prussic acid per pound of root was obtained, from others only one-tenth as much." "Boiling the root is quite sufficient not only to destroy the enzyme, but also to allow the glucoside to pass out into the water, for the root splits up freely." Dunstan and Henry (*Pois. Prop. Beans of Phaseolus lunatus*, in *Journ. Board Agri.*, 1908, xiv., 730) are of opinion that the application of enough heat to destroy the activity of the enzyme present should render such food material harmless. (See **Phaseolus lunatus**, p. 880.) In MEDICINE tapioca has the same properties and uses as starch. Hanausek (*Micro. Tech. Prod.* (Winton and Barber, transl.), 1907, 45) gives interesting details of his microscopical examinations of the grain. [*Cf.* Shortt, *Man. Ind. Agri.*, 1885, 307–10; Nicholls, *Textbook Trop. Agri.*, 1892, 274–8; *Pharmacog. Ind.*, iii., 203–5, app.; Sawyer, *Tapioca Cult. in Travancore*, in *Proc. and Journ. Agri.-Hort. Soc. Ind.*, April to June, 1897, xi., 666–74; *Agri. Ledg.*, 1897, No. 4; 1900, No. 15; 1904, No. 10; *W. Australian Settlers' Guide and Farmers' Handbook*, 1897, iii., 456; Thorpe, *Dict. Appl. Chem.*, 1898, i., 446–7; 1899, ii., 503; 1900, iii., 781; Woodrow, *Gard. in Ind.*, 1899, 442–3; Mukerji, *Handbook Ind. Agri.*, 1901, 468–77; *Cassava Poisoning*, in *Imp. Dept. Agri. W. Ind.*, 1902, No. 7 (Leaflet Series); *Bull. Dept. Agri. Jamaica*, 1903, i., 35–8; *Board of Trade Journ. Bull. Imp. Inst.*, May 1903; Tracy, *Cassava*, *U.S. Dept. Agri. Bull.*, 1903, 167.]

Cyanogenetic Glucoside.

Prussic Acid.

Medicine.

MANURES AND FERTILISERS.—The most general vernacular names in India for manures are:—*khad, khau, páus, khadar, sar* or *sarra, kallar*, etc.; *páusa*, Sansk.; and *zibl*, Arab.

D.E.P., v., 167–77
Manures.

Speaking of India as a whole, it may be said that systematic manuring is almost entirely neglected by the Natives. From the most ancient times they have been accustomed to observe a casual system of manuring, namely the collection of such substances as are inexpensive and easily obtainable. Moreover, by the very general employment of dried cow-dung as fuel and the utter neglect, through insufficient litter, to conserve cattle urine, they have been deprived of the most important source of all fertilisers and the one readiest to hand, namely farm-yard manure. Caste prejudices, moreover, have to a great extent forbidden the employment of many manures such as bone, animal refuse, night-soil, etc. Still, here and there the value of manure is fully understood (as, for example, in some parts of the Western Presidency); and in the treatment of special crops (such as sugar-cane) manuring is regularly practised. But neither example nor precept have, as yet, succeeded in arousing the average Native cultivator to a sense of the benefits likely to accrue from an extended use of manure beyond that pursued by his ancestors. But in all fairness it must be added that in the majority of cases this apathy proceeds far less from ignorance than from inability to purchase soil-fertilisers. The most urgent necessity of agricultural progression in India is, therefore, a system of fuel and fodder reserves calculated to release the supply of farm-yard manure for its more legitimate purpose, that of a soil-fertiliser.

Cow-dung Fuel.

Caste.

Sugar-cane.

Inability.

Fuel and Fodder Reserves.

MANURES AND FERTILISERS

Water and Manure.

Voelcker (*Improv. Ind. Agri.*, 131) has very properly said: "Whilst a few soils, such as those of silt-renewed tracts, the black cotton-soil, and newly reclaimed or virgin land, may not require manure, it may be said of the greater part of India that the necessity for using manure is enormous, and the supply of it is notoriously inadequate. Water and manure are interdependent, and, just as the former has been, and is still being provided for, so must attention be given to the supply of manure. These two factors, water and manure, constitute the *raiyat's* great needs, and in their supply consists, very largely, the Improvement of Indian Agriculture."

In dealing with Manures and Fertilisers it may be convenient to assort them under three main groups, namely Animal, Vegetable and Mineral Manures:—

Animal Manures.

I. Animal Manures.—These may be referred to the following (*a*) Farm-yard Manure; (*b*) Town Refuse and Night-soil (Poudrette); (*c*) Bones; and (*d*) Guano.

Farm-yard.

Fuel Supplies.

Cattle Urine.

Nitric Acid.

Farm-yard Manure.—It would be impossible to review here the very large amount of interesting new information that has accumulated during the past decade or so regarding Indian farm-yard manure and its uses. The chief contributors in this direction have been Benson, Leather, Lehmann, Mehta and Mollison. Leather, in his *Final Report*, points to the fact that throughout the greater part of Gujarat, farm-yard manure is extensively utilised *as a manure, not as a fuel*, and with much skill and intelligence is stored in specially prepared pits. Benson deals with a somewhat similar state of affairs in Coimbatore and Salem. But what is more to the point, the people who do so find no difficulty in growing for themselves, in the form of hedges and otherwise, the fuel that they require for domestic purposes, and thus disprove the oft-affirmed opinion that, having no other fuel, the people of India are driven to burn their manure. In many parts of India even the surplus cow-dung—the proportion that is not required for fuel—is rarely appreciated to the full extent as manure. It is all too often thrown into waste hollows or on the roadsides or on the bank of the village tank, in most cases becoming a source of danger in place of an advantage. Very rarely indeed is any effort made to preserve and utilise the cattle urine. This is a most unfortunate state of affairs seeing that it has been shown in Europe and America most conclusively that farm-yard manure is, perhaps, the best and certainly the most economical of all manures. It contains all the constituents of plant food; is a most valuable and convenient source of nitric acid; its nitrification is most active at the very period of greatest growth; as a manure it is less liable to be washed out of the soil than most artificial nitrogenous fertilisers; it permanently enriches the soil; and acts under all climates, on all soils and with all crops.

Results.

Leather says that Indian experiments show that when an application of 6 tons to the acre is given, an increase of 300 to 400 lb. of wheat may be the result. After ascertaining that such an allowance would not be beyond the capabilities of the cultivator, he adds, "consequently these experiments really illustrate what the value of the cattle manure is in terms ot food-grains." Moreover he confirms the opinion, advanced originally by Voelcker, that "Indian dung is not poorer than English." [*Cf.* Leather, *Note on Value of Ind. Cattle-dung*, in *Nagpur Exp. Farm Rept.*, Annex. F, 1893–4, 1–10; *Econ. Util. of Cow-dung and Ráb. in Bomb.*, in *Ind. For.*, 1886, xii., 541–5; Benson, *Care and Manag. Farm Man. in South India, Bull.* 1894, No. 31; Watt and Mann, *The Pests and Blights of the Tea Plant*, 130–4; Clouston, *Cattle Manure*, in *Agri. Journ. Ind.*, 1907, ii., pt. iii., 261–9.]

Night-soil.

Disposal.

Shallow Trenching.

Town Refuse, Night-soil and Sewage.—The question of the disposal of night-soil and its utilisation for manurial purposes is one which has been, of late years, earnestly considered throughout India by all Governments and Municipalities. In large towns night-soil and street refuse are removed at the expense of the local authorities, but the question arises as to its disposal. The most general practice is to trench it into fields and by its means to reclaim waste land. For this purpose, in some cases deep, in others shallow trenches are employed. Leather remarks, "It is at Allahabad Grass Farm that I have found the most perfect methods employed. The night-soil is here usually trenched, but instead of the trenches being narrow and deep, about 1 foot by 1 foot, they are really shallow beds, about 14 by 5 feet and only 3 inches deep. A cart-load of night-soil is thrown on, and the excavated 3 inches of earth put back upon it. I have several times, when at Allahabad, dug up these "beds" in which the night-soil had been placed only a few days previously, and found no objectionable odour." "In deeper trenches the decomposition takes naturally longer, but at Meerut I found that a fortnight had been ample for the purpose." In the shallow system the manure is distributed over a larger area, and thus more usefully; with deep trenching as much as 200 tons per acre may be given in the year, whereas one-tenth or one-twentieth would have been ample. In many instances a kind of snow-plough is run over the ground and shallow furrows thus excavated, into which liquefied night-soil is run. Deep and Shallow Trenching.

Of the manufacture of poudrette it may be said there are many advantages, and disadvantages. Of the latter, the chief is the fact that the atmosphere of the locality in which the pits are located becomes almost uninhabitable. Still, the poudrette, when prepared, may be carried to great distances and thus utilised over a wide area. The increasing demand for the poudrette of certain towns is indicated by the continuous increase in the price at which it is disposed of. In fact it may be said that the night-soil of many cities has become a source of revenue, so that much progress has taken place. All that is necessary is to extend the demand from the vicinity of the cities to that of the villages, in order to secure a much-needed sanitary reform and great agricultural advance. [*Cf.* Buck, *Employ. City Refuse for Agri. Purposes at Farukhabad*, 1872; Moreland, *Use of Town Drainage as Manure*, in *U. Prov. Bull.*, 1901, No. 18; *Ann. Rept. on Working of Sewage Farm, Manjiri*, 1902-3; Leather and Mollison, *Agri. Value of City Sewage in India*, in *Agri. Ledg.*, 1903, No. 2; Joshi, *The Util. of Night Soil as Man.*, *C. Prov. Bull.*, 1901, No. 5.] Poudrette.

Bones (see p. 169). Bones.

Guano and Allied Manures.—The excrement of fowls, pigeons, wild birds and bats, etc., may be said to be all forms of the substance known as GUANO. It is one of the most highly prized animal manures in European countries, and owes its value to the readily soluble ammonia, phosphates, potash and soda that it contains. A small amount of this substance is annually imported into India, and it has been ascertained to be of special value in protecting sugar-cane cuttings from being attacked by white-ants. Mollison says it is one of the best manures for wheat, 2 to 3 cwt. an acre being sufficient. It acts rapidly and is expended almost entirely on the crop to which applied. Guano. For Wheat.

Indian guano is not unknown. It is procured from the caves in Karnul and of the Andaman and Nicobar Islands. The former is possibly mainly the produce of bats, and the latter of the edible swallows (see **Birds**, p. 138). The imports during the past five years have averaged 2 tons, valued at Rs. 700. [*Cf. Encycl. Brit.*, 1880, xi., 233 *et seq.*; Spons, *Encycl.*, 1882, i., 358; ii., 1258; *Journ. Soc. Chem. Indust.*, 1887, vi., 228; 1888, vii., 84 *et seq.*; 1899, xviii., 213 *et seq.*; Thorpe, *Dict. Appl. Chem.*, 1899, ii., 504 *et seq.*; *U.S. Yearbook, Dept. Agri.*, 1899, 274 *et seq.*; *Board of Trade Journ.*, 1901, xxxiii., 72 *et seq.*; 1902, xxxix., 201-2.] Indian Supply.

Fish Manures. (see pp. 543-4). Fish.

II. Vegetable Manures.—Many vegetable substances, such as boughs and leaves of bushes and trees, indigo refuse, wood-ashes, weeds of every description (green, dry and burnt), oil-cakes, tank deposits consisting largely of aquatic weeds, etc.,—these and such like are, when obtainable, fairly extensively used as manure here and there all over India. They are usually thrown on the surface of the land and ploughed or hoed into the soil in a fresh state, where they only too frequently become a nidus for insect pests and fungal blights. Except by market gardeners and by tea and coffee planters, pits or heaps are rarely resorted to for the storage and maturation of vegetable manures, and as often as not the stuff casually secured is thrown on the field at the wrong season, and thus becomes next to useless. The following are the chief manures of this class:— **Vegetable.** Mould.

Green Manuring and the Assimilation of Nitrogen.—As with the clover in Europe so with several leguminous crops in India, their value as alternating **D.E.P., v., 174.**

Green Manuring.

Leguminous Crops.

Advantages and Requirements.

crops or as green manure was appreciated for centuries before their exact action was understood. The chief crops of this nature are **Cajanus** (see pp. 197–8), **Cicer** (see p. 298), **Crotalaria** (p. 433), **Dolichos** (p. 504), **Indigofera** (pp. 672, 679), **Phaseolus** (pp. 225, 879), and **Vigna** (see p. 1107). It is significant that all these, and a good few others that might be mentioned, belong, like clover, to the special sub-order of leguminous plants that have been shown to possess in the strongest degree the power of producing on their roots, warts that harbour bacterial organisms that have the power of fixing the free nitrogen of the air and thus enriching the soil. Unless, therefore, leguminous crops have been grown so extensively as to render some other plant a desirable rotation, it is preferable in green manuring to select a leguminous crop for that purpose. In that way the advantages of green soiling as well as the supply of nitrogen to the soil may be secured. A green manure should, in fact, be a plant that develops rapidly; should give the largest volume of green vegetation; should be as deep-rooting as possible, thus opening up the soil to a fair depth; should be sufficiently hardy as to flourish under what might be called unfavourable conditions; should occupy the soil and the atmosphere at a season when the crop it is designed to assist is either not on the soil or not growing vigorously at the time; should return more to the land than it has removed; should serve to retain manurial constituents that might otherwise be washed out; and lastly, should easily rot when hoed into the ground. [*Cf.* Gilbert, *Fixation of Free Nitrogen*, Lect. deliv. at Cirencester, July 1890; Lawes and Gilbert, *Sources Nitrogen of Legum. Crops*, 1892; Warrington, *Six Lect. on Rothamsted Exper. Stat., etc., U.S. Dept. Agri. Bull.*, 1892, No. 8; Frankland, *The Chem. and Bacteriology of Ferment. Indust.*, in *Journ. Soc. Arts*, 1893; *Agri. Ledg.*, 1893, No. 20, 141–3; 1894, No. 7, 189–200; 1897, No. 8, 173–5; *Nitrogen and Forest Crops*, in *Ind. For.*, 1897, xxiii., 439–52; *Green Manuring*, in *Journ. Board of Agri.*, 1897, 1–10; *Fixation of Atmospheric Nitrogen of Legum. Pl.*, *West Ind. Bull.*, 1900, i., 396–401; Mollison, *Textbook Ind. Agri.*, 1901, i., 105–7; Allen, *Legum. Pl. for Green Manuring, U.S. Dept. Agri. Farmer's Bull.*, 1894, No. 16; Watt and Mann, *Pests and Blights, etc.*, 1903, 134–47; *Nitrogenous and Nematode Pl., Circ. Agri. Journ. Roy. Bot. Gard. Ceylon*, 1904, No. 18, 273–7; Wright, *Soil Bacteria in Relation to Agri.*, in *Trop. Agrist.*, 1905, xxiv., 116–9; *Green Manures, Circ. Agri. Journ. Roy. Bot. Gard. Ceylon*, 1905, iii., 181–98; Woods, *Inoculation of Soil with Nitrogen—Fixing Bacteria*, in *U.S. Dept. Agri. Bureau. Pl. Indust. Bull.*, 1905, No. 72.]

Jumming.

Rábing.

Burning or Rábing and Jumming.—Burning of weeds in heaps collected all over the fields is less commonly seen in India than in Europe. Aboriginal tribes are fond of cutting down the trees and brushwood and firing these on the surface of the soil a process of both clearing new land and manuring it with vegetable ash. This is known as *jumming.* A civilised modification of this is pursued in Western (and to some extent also in Southern) India. Seed-beds or even whole fields are manured by what is called *ráb*. This consists in burning the surface soil by means of layers of dried manure, leaves, branches and weeds. After the burning has ceased, the soil and ashes are ploughed in, and thus mixed together. The reader will find much useful information regarding the production of *ráb* soil in Mollison (*Textbook Ind. Agri.*, i., 83–5).

Silt.

Peat-soil.

Top-dressing of Soil by silt from canals and streams or by the soil from dried-up tanks, *bhíls*, etc., is a subject that has attracted much attention recently. To the tea-planter a dressing of "peat *bhíl* soil" has been proved in some cases profitable, but it is feared soil of comparatively little value has, in many cases, been used in top-dressings, with the result that the cost has far exceeded the value. Much, therefore, depends on the quality of the *bhíl* soil available. What may be called peaty soil is formed by the decay of many generations of rank growing plants, especially if the decomposition has been accomplished under water. Soil of that nature is most valuable, and has with great advantage been used in many tea estates. [*Cf. Pests and Blights, l.c.* 122–30.] For many other crops silt deposits have been highly commended. For example, of this nature may be mentioned the special cultivation of ground-nuts in South India, manured with tank-soil (see p. 79). [*Cf.* with Leather, *Agri. Ledg.*, 1897, No. 8, 172–3; *Silt of Rivers as Manure*, in *Journ. Board Agri.*, 1897, iv., 351.]

D.E.P.,
v., 463–79.
Oil-cake.

Oil-seed Cake—The Indian cultivators fully recognise the value of oil-seed cake or the refuse of such, both in feeding cattle and as manures of great value. The edible sorts of oil-cake, such as **Linseed** (see p. 731), **Rape and**

Mustard (p. 184), **Safflower** (p. 283), **Til** (p. 986), **Cotton** (p. 613), **Earth-nut** (p. 82) and **Cocoanut** (p. 360) are much favoured as cattle foods, while the others that may be classed as non-edible are largely used as manure, the most important of this latter class being **Castor-oil** (see p. 922); but **Poppy** (p. 860) and **Mahua** (p. 120) may be added. With highly profitable crops, such as sugar-cane, many of the edible cakes are occasionally employed as manures. Mollison points out that the cultivators in this respect often act against their own interests, since the castor cake very often fetches a higher price than some of the edible cakes which they refuse to use as manure. The advantage to India of the oil-seeds being expressed in the country, instead of being exported, has been repeatedly urged (Voelcker, *l.c.* 104). Profitable labour would be secured for many persons and a larger percentage of cake retained and to a greater extent than at present, very possibly, returned to the soil. The *Annual Reports* of the various Agricultural Departments and Experimental Farms of India have for many years past abundantly demonstrated the value of the cakes as special manures. [*Cf.* Leather, *l.c.* 157–62; Mollison, *l.c.* 122–33; Lehmann, *Comm. Fertil.*, in *Agri. Journ. Ind.*, 1906, i., pt. ii., 123–6; also see article **Oils and Oil-seeds**, p. 818.]

Advantages of Oil Mills.

Production of Cake.

Special Plants as Manures.—**Adhatoda** (see p. 25); helpful vegetation (see pp. 54, 113–4). Plants with milky sap, such as **Calotropis** (pp. 53, 206) and **Euphorbia** (p. 530), are specially preferred; the refuse of **Indigo** (*seet*, see p. 679); and many other such substances are valued as manures and often resorted to by the cultivators. The reputation of ***Adhatoda***, both as a manure and a poison to destructive organisms that appear in the flooded rice-fields, is specially worthy of attention.

III. Mineral Manures.—Though several very valuable manures of this kind exist plentifully in many parts of India, their value and uses are hardly anywhere appreciated. Some of these have already been so fully dealt with in other positions in this work that all that need be necessary is to furnish cross references:—

Mineral.

Lime.—(See p. 712). As a rule lime is present in such abundance in the agricultural tracts as scarcely to require its addition as a manure.

Lime.

Gypsum.—(See p. 717).

Gypsum.

Ammoniacal Liquors and Ammonium Sulphate as Manures.—(See pp. 48, 346.) Sir John Lawes has pointed out that the objection to sulphate of ammonia and all other "highly nitrogenous" manures, is that "they use up certain natural ingredients in the soil, which when exhausted cause the plant to fail." In a further communication he condemned sulphate of ammonia, because it removes lime from the soils. Where the percentage of lime is naturally low, as for example in the tea lands as a whole, it should not be used, or only in exceptional cases. All artificial manures have the further objection that in countries subject to heavy rains, soluble manures are very readily washed out of the soil, so that their action is often only temporary; a fall of rain of only a very few inches may suffice to remove them entirely. For crops that occupy the soil for brief periods only, such as wheat and barley, if given in combination with potash either present in the soil or added as an ingredient of the special manures, these chemical nitrogenous fertilisers may be of special value. [*Journ. Soc. Chem. Indust.*, 1899, xviii., 486; Mollison, *l.c.* 117–8; Watt and Mann, *l.c.* 154–5.]

Ammonium Sulphate.

Nitrates.—The nitrates of potash and soda are both largely employed as manures. In a crude sort of fashion the Native cultivators of India here and there show that they are aware of the value of crude saltpetre as a manure by the value they place on surface soil collected near the homestead. Certain localities, as for example Bihar, have been noted from time immemorial for the large stores of saltpetre found naturally in the soil, and such localities have accordingly been famed centres for the production of the salt. Saltpetre is specially valued as a manure with tobacco, sugar-cane, and garden crops generally (see **Saltpetre**, p. 974). [*Cf.* Mollison, *l.c.* 119–21; Leather, *Calcium Nitrate and Nitric Acid*, in *Agri. Journ. Ind.*, 1907, ii., pt. ii., 209–10.]

D.E.P., v., 175–6.

Saltpetre.

Potash Manures: Pearl Ash, Kainit, etc.—Saltpetre is valued not only as a source of nitrogen, but on account of its potash. Continuous cultivation and removal of crops must, therefore, gradually lower the stores of this all-important material. With the return to the soil of decomposed vegetable matter or of plant ashes, the potash is to some extent restored. But sooner or later it must

Potash.

Rice Husk.

be added as manure if fertility is to be preserved. To the Natives of India potash may be said to be summed up in **Pearl Ash** (see p. 49). Plant ashes have been for centuries valued for high-class cultivation. The subject is closely akin to *rábing and jumming* (see above, p. 770). The value of wood-ashes as manure will be found discussed in many Indian publications, such as the *Indian Forester* (1879, iv., 284–5). Rice husk, almost worthless as a cattle food, is of great value as a manure, because of the high percentage of potash it contains. So also the refuse skimmings, in the process of sugar manufacture, are much valued, and indigo refuse is also rich in potash. Recently, however, certain natural minerals have come into the market as special potash-yielding manures. Of this nature is *kainit*, which contains 13 to 14 per cent. of potash. When calcined it is greatly improved, and may be given at from 2 to 4 cwt. to the acre. It is useful on light lands rather than on clay soils. Large beds of this substance have been discovered in Germany.

Phosphates.
Bones.
Sulphuric Acid.
Phosphatic Nodules.

Phosphates and Phosphatic Manures, Basic Slag, etc.—The phosphoric acid required by plants is one of the soil ingredients liable to be exhausted by continuous cropping, and must be supplied in the form of manure. It is on this account that pastures are liable to get worn out. The principal manures of this class are bones, superphosphates and reduced phosphates. Space cannot be afforded to revert to the subject of bones and the special preparations made from them (see p. 169). But it may be here observed that large fossilific deposits have been found in many countries rich in phosphates. Holland (*Rev. Min. Prod.*, in *Rec. Geol. Surv. Ind.*, 1905, xxxii., 112–4) says of India, "One regretful feature" . . . " is the absence, in a country where agriculture is such a prominent industry, of any phosphatic deposits of value, and a further circumstance to be regretted is the continued export of phosphates in the form of bones, due primarily to the fact that, being without means for the manufacture of cheap sulphuric acid, superphosphates are not made in the country, and the little that is used is imported from Europe." "Amongst the phosphatic deposits of India, the principal and perhaps the only one worth considering is the deposit of phosphatic nodules of the septarian kind, occurring in the cretaceous beds of the Perambulur taluk, Trichinopoly district, Madras Presidency. Dr. H. Warth, in 1893, estimated that to a depth of 200 feet the beds contained phosphates to the amount of about 8 million tons, but the nodules are distributed irregularly through clay, varying, in the different deep excavations made, between 27 and 47 lb. per 100 cubic feet, and in some shallow diggings 70 lb. per 100 cubic feet. Analyses of these nodules show them to contain from 56 to 59 per cent. of phosphate, and about 16 per cent. of carbonate of lime, with considerable variations in different nodules. The alumina and oxide of iron vary between 4 and 8 per cent." Two attempts made to utilise these deposits have proved futile, and it is believed there is no present prospect of mining for export. [*Cf.* Hooper, *Effects of Phos. Man. in Jalap Cult.*, *Pharm. Journ.*, July 1896; Sly, *Min. Fertil. in Ind.*, *Agri. Journ. Ind.*, 1906, i., pt. iii., 243–6; Leather, *Mem. Dept. Agri. Ind.*, 1907, i. (Chem. ser.), 45–57.]

Basic Slag.

Basic Slag, a by-product in the manufacture of steel, and until recently a waste product, came into use as a phosphate and lime manure. It is ground to a fine powder, and in soil moisture is at once dissolved and rapidly absorbed by the roots. As it contains much iron it is not suited for soils already rich in that substance. [*Cf.* Hughes, *Journ. Soc. Chem. Indust.*, 1901, xx., 325 *et seq.*; Hooper, *Agri. Ledg.*, 1898, No. 20.]

Manure Works.

Indian Manure Works.—It would, perhaps, be invidious to attempt an enumeration of the bone-mills of India (further than has already been given, p. 169), since these by no means represent all the manure works, nor the firms that trade in indigenous and imported manures.

Trade.
Bones.

Trade.—The traffic in manures is not an extensive one, and, when bones are eliminated, is hardly worth mentioning. The total exports in 1901–5 were valued at Rs. 43,77,841, of which Rs. 37,51,480 were bones, and in 1906–7 at Rs. 1,01,54,892, of which Rs. 55,45,241 were bones. But one point is worthy of consideration, viz. while the exports of raw bones have been declining steadily for some years past, the exports under the heading of Others (excluding oil-cakes) have been steadily increasing. In 1900–1 the exports of bones were valued at Rs. 58,41,916,